SOLAR Heating
for Industrial Process
Together Toward Efficient Production

SWH training: Presentation

Training of SWH installer & maintainer

Ministry of Trade & Industry
وزارة التجارة والصناعة

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Solar Water Heaters training
Presentation of the frame

Objective of the introduction:

- ✓ Be informed on SWH training program
- ✓ Introduction to SHIP project and the benefit form the training and the impact of the training on the SHIP project
- ✓ Have knowledge on 5 days training
- ✓ Be aware with the rules

Duration

- ✓ From : 09:00 to 09:30
- ✓ Close phones
- ✓ Don’t speak to each other

Solar Water Heaters training
Presentation

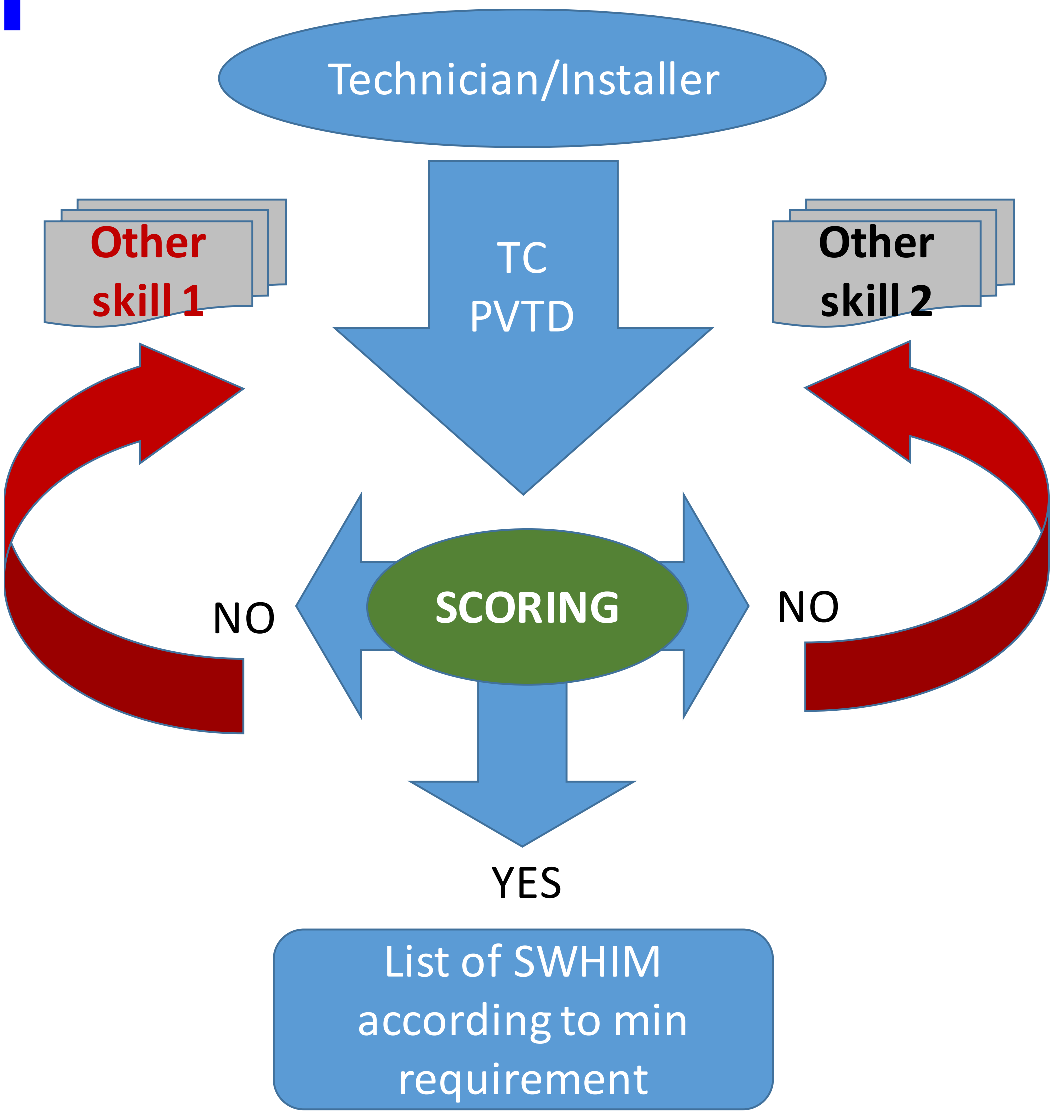
Objective of the training:

✓ The training is targeting the existing technicians aiming to become qualified installers in the following segment of SWH market:

- Installation of individual SWH (1 to 4 m^2)
- Installations of SWH system from 4 m^2 and up to 30 m^2 of collectors
- Installation of SWH system more than 30 m^2 of collectors

YE7

Solar Water Heaters training
Presentation



Competency based program for existing installers (5 days)

ToT

Minimum requirements for training Centres

Introduce SWH assessment

- Theory
- Practice
- interview

Qualified SWH installer and maintainer

YE7

The training is targeting the existing technicians aiming to become qualified installers in the :following segment of SWH market

Installation of individual SWH (1 to 4 m^2) .1

Installations of SWH system from 4 m^2 and up to 30 m^2 of collectors .2

Installation of SWH system more than 30 m^2 of collectors .3

Yahia El-Masry, 03-Aug-20

Solar Water Heaters training
Presentation

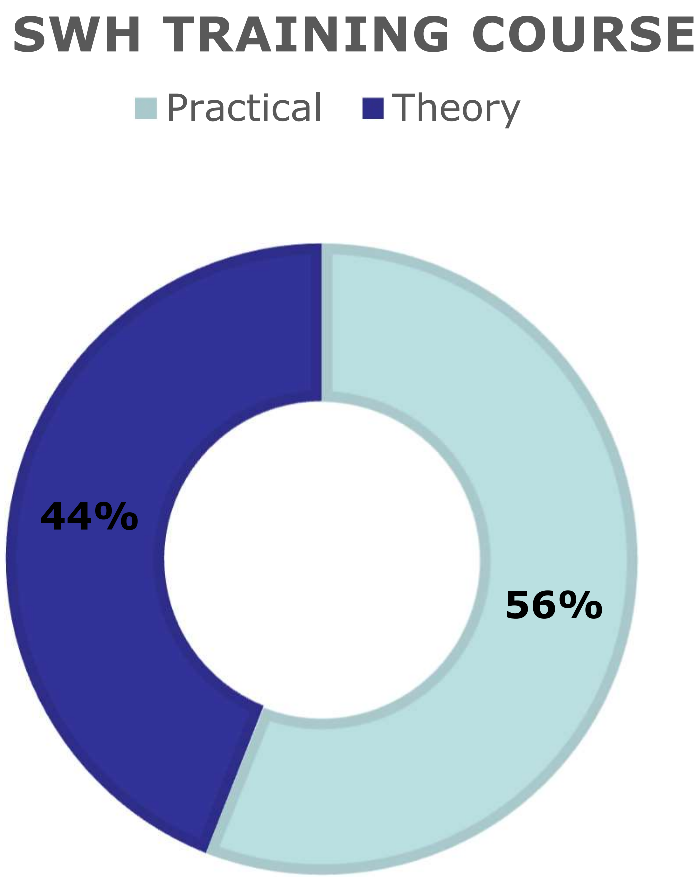
5 days training:

- ✓ 4 days training face to face
- ✓ Training is theory and practice
- ✓ Last day is for examination

Timing

- ✓ **Day 1 (T):** Definition, technologies, site survey, installation techniques
- ✓ **Day 2 (P+T):** SWH Installation, commissioning and best practices
- ✓ **Day 3 (T+P):** Forced system manipulation and installation
- ✓ **Day 4 (P+T):** Maintenance and repair, market organizational scheme
- ✓ **Day 5 (T+P):** Examination (theory and practice)

Solar Water Heaters training
Presentation



Solar radiation
SWH Definition
SWH technology
Performs site survey
Installation techniques
Maintenance overview
Installation of TSWH
Installation of FSWH
Maintenance diagnosis
Theory exam

Installation of TSWH system
Installation of forced SWH system
Safety, tools
Measurement
Maintenance and diagnosis of breakdowns
Procedural framework
Practical examination

56% Practice = 16,75 h (10 blocks) / 44% Theory = 13,25 h (8 blocks)

Solar Water Heaters training
Presentation (day 1)

Timing	Day 1
Trainer	
9.00-10.30	Welcoming Participants Participants presentation Participants pre-evaluation World, regional and Egyptian solar thermal context
10.30-10.45	Coffee break
10.45-12.30	Solar radiation: -Solar data, orientation, inclination, solar power, sun-earth relationship, atmospheric effects….. SWH Definition -Thermosiphon and forced circulation definition - Components of SWH and accessories SWH technology (1) - Direct and indirect systems
12.30-13.30	Lunch break

Solar Water Heaters training
Presentation (day 1)

13.30-15.00	**SWH technology (2)** - Difference between thermosiphon and forced circulation systems - The role and function of each component and accessory Technical drawings : - Interpret different types of designs and diagrams -Identify the specification of the pipes
15.00-15.15	Coffee break
15.15-17.00	Performs site survey - Parameters optimizing the location and the performance of a SWH - Check list of hazards in the site - The needs depending on existing situation Installation techniques - Check list of required materials, tools and safety equipment - Preparatory work for the installation - Overview of the different steps of SWH installation Technical advice and requirements for a good installation Overview of Maintenance and repair - Preventive and curative maintenance requirements - Diagnosis of breakdowns and failures **End of the Day 1**

Solar Water Heaters training
Presentation (day 2)

Timing	Day 2
Trainer	
9.00 – 10.30	**Installation of SWH system (1)** - Pre-installation preparation in site - Components inspection in site - Metallic structure assembling ✓ Structure for collectors ✓ Structure for tank ✓ Stone concrete fixation
10.30 – 10.45	**Coffee break**
10.45– 12.30	**Installation of SWH system (2)** - Collector installation ✓ Individual collector ✓ Series collectors - Tank installation ✓ Horizontal position ✓ Water pressure - Connection between different components ✓ Cold water connection ✓ Hot water connection
12.30 – 13.30	**Lunch break**

Solar Water Heaters training
Presentation (day 2)

13.30 – 15.00	**Installation SWH system (3)** - Installation of accessories for SWH, before commissioning ✓ Safety valve for over pressure protection ✓ MG Anode for water prevention ✓ Thermostat for temperature setting ✓ Backup system for heating water ✓ Electrical connection ✓ Earth for equipment and person protection
15.00 – 15.15	**Coffee break**
15.15 – 17.00	**Installation SWH system (3)** - Commissioning the installation - Best practices for installation of SWH **End of Day 2**

Solar Water Heaters training
Presentation (day 3)

Timing	Day 3
Trainer	
9.00 – 10.30	Installation of forced SWH system - What is it? - Collector installation drawings ✓ Individual collector ✓ Series collectors - Tank installation drawings ✓ Horizontal position ✓ Water pressure ✓ Circulator
10.30 – 10.45	Coffee break
10.45– 12.30	Installation of forced SWH system - Collector installation ✓ Individual collector ✓ Series collectors - Tank installation ✓ Horizontal position ✓ Water pressure ✓ Circulator
12.30 – 13.30	Lunch break

Solar Water Heaters training
Presentation (day 3)

13.30 – 15.00	**Installation of forced SWH system** - Connection between different components ✓ Cold water connection ✓ Hot water connection
15.00 – 15.15	**Coffee break**
15.15 – 17.00	**Safety equipment** ✓ Individual ✓ Collective **Tools** ✓ Individual tools ✓ Collective tools **Measurement devices** Commissioning the installation Best practices **End of Day 3**

Solar Water Heaters training
Presentation (day 4)

Timing	Day 4
Trainer	
9.00 – 10.30	**Maintenance and diagnosis of breakdowns** - Preventive maintenance ✓ Guarantee ✓ List of preventive maintenance ✓ How to do it??
10.30 – 10.45	**Coffee break**
10.45– 12.30	**Maintenance and diagnosis of breakdowns** - Curative maintenance ✓ List of problems ✓ Solutions
12.30 – 13.30	

Solar Water Heaters training
Presentation (day 4)

13.30 – 15.00	**Maintenance and diagnosis of breakdowns** - Trouble-shooting and repair techniques
15.00 – 15.15	**Coffee break**
15.15 – 17.00	**Procedural framework** - Technical specification relating to the SWH components eligibility - Conditions for adherence to the Quality-Sol charter - Guideline of best practices SWH installation and maintenance **Procedural framework** - Supplier/installer contract - Minimum requirements for installer/maintainer eligibility - Technical specification related to supplier eligibility **End of Day 4**

Solar Water Heaters training
Presentation of examination conditions

Last day of training:

✓ Examination : part 1

- Theory Post evaluation
- 40 QCM/2:00 hours

✓ Examination: part 2

- Practical Post evaluation
- Real installation and maintenance /2:00 hours)

Score

✓ **Written: 40 points**
✓ **Practical: 50 points**
✓ **One to one interview: 10 points**

Solar Water Heaters training
Presentation of rules

Rules:

- ✓ Absence: more than 10% of the training duration, the candidate is deemed guilty
- ✓ Plagiarism: work that has been copied from that of another person (whether published or not) without attribution, or the presentation of another's work as if it were his/her own.
- ✓ Purchasing material/work undertaken by others and presenting as own work.
- ✓ Selling material: Selling or offering to sell, by whatever means, material, or using other inducements, to assist a candidate in producing work for assessment.
- ✓ Collusion: where a candidate undertakes work with or for others, without acknowledgement (e.g. submits as entirely his/her own, work completed in collaboration with another person).
- ✓ Falsifying data: that is where a candidate presents data based on work which a he/she claims to have carried out but which he/she has invented or obtained by unfair means.

SOLAR Heating for Industrial Process

Together Toward Efficient Production

SWH: International context

Training of SWH installer & maintainer

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Solar Water Heaters
International context

Objective:

- ✓ Knowledge on renewable energy Technologies
- ✓ Be informed on SWH in the word
- ✓ Have knowledge on main SWH technologies
- ✓ Who are the Champions in the word?

Duration

- ✓ 1:30 hour
- ✓ From : 09:00 to 10:30
- ✓ Close phones
- ✓ Don’t speak to each other

RENEWABLE ENERGY TECHNOLGIES

Renewable energy introduction

Why Renewable energy ?

- **The development and demographic growth of the continents**

  → Energy consumption increase

- **Ecological risks** → Global warming due to the greenhouse effect
  Nuclear waste management

- **Energy sources diversification** → Energy independence

- **Job creation** → Creation of new professional streams

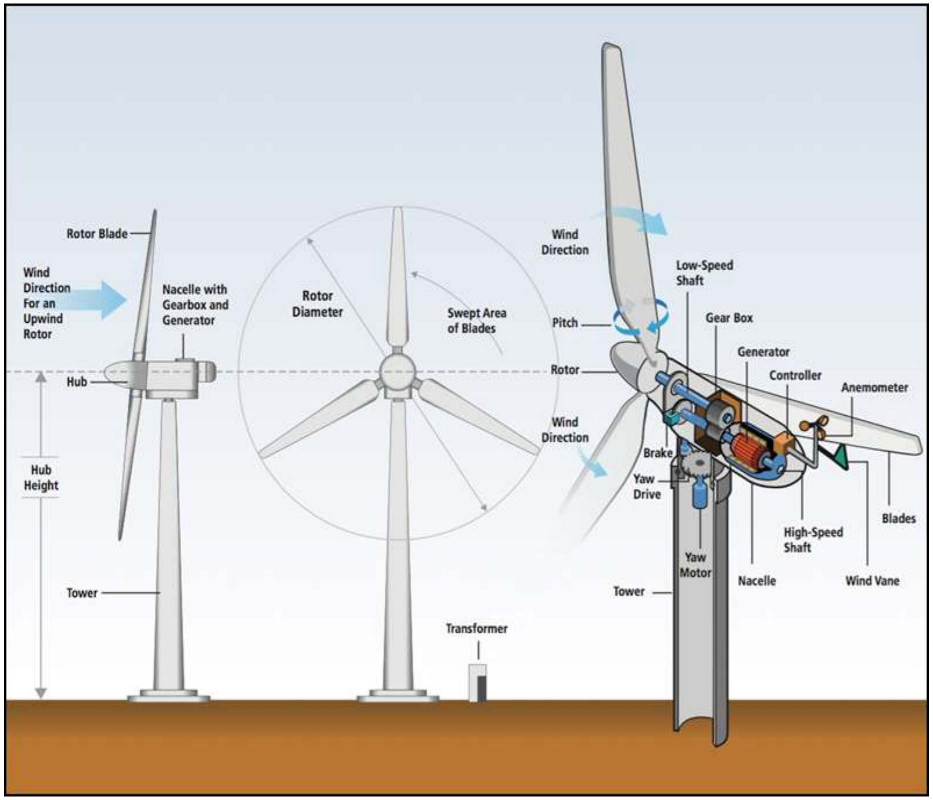
RENEWABLE ENERGY TECHNOLGIES

Renewable energy Technologies

- ❖Wind power
- ❖Hydro-electricity power
- ❖Concentrated solar power
- ❖Photovoltaic
- ❖Biomass
- ❖Solar thermal

RENEWABLE ENERGY TECHNOLGIES

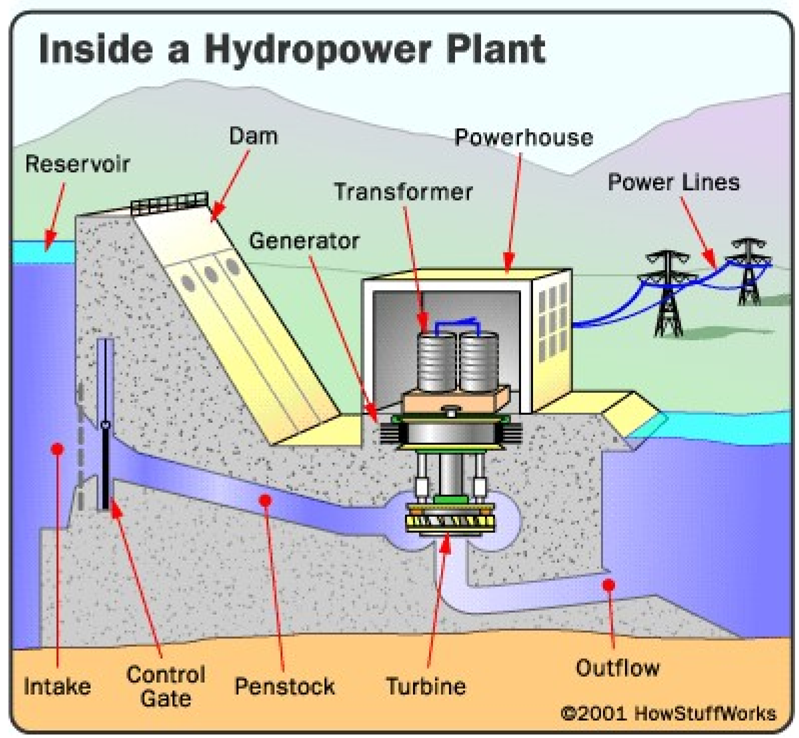
Wind power Technology



Source: IPCC, 2012, p. 552

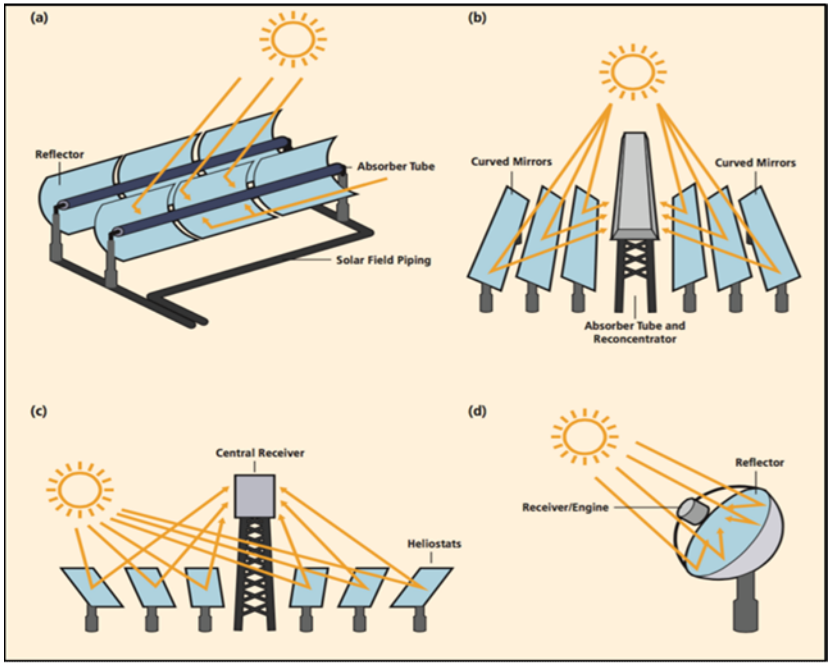
- Carbon free energy which use wind to provide the mechanical power through wind turbines to turn electric generators
- Intermittent energy
- Energy lost if it is not used
- The cheapest of the renewable options

RENEWABLE ENERGY TECHNOLGIES
Hydro-electricity Technology



- Is produced when moving water rotates a turbine shaft; this movement is converted to electricity with an electrical generator

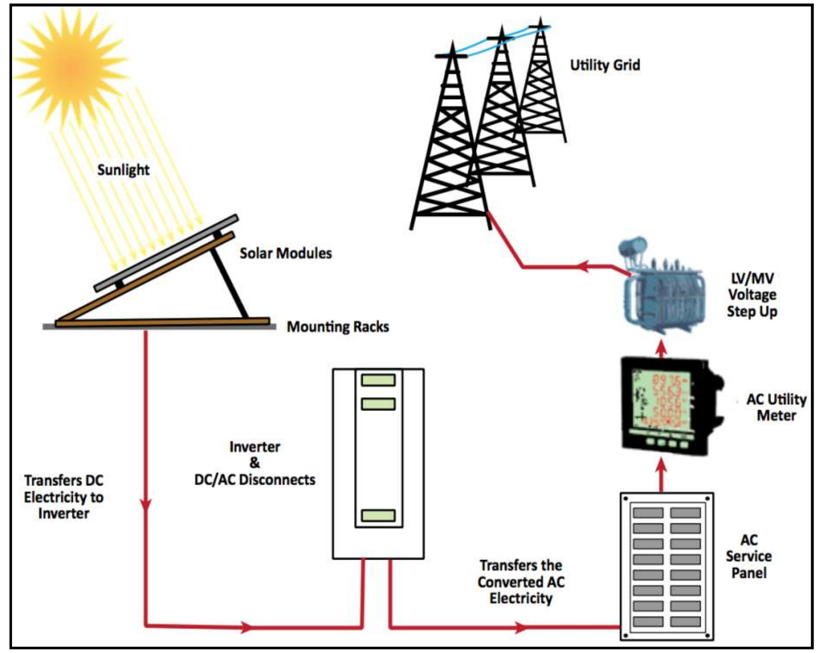
RENEWABLE ENERGY TECHNOLGIES
Concentrated solar Technology



Source: IPCC, 2012, p. 356

- It consists of concentrating solar radiation by using mirrors or lenses to heat a fluid to a high temperature and thus produce electricity or supply energy to industrial processes
- Carbon-free energy and consumes a lot of soil
- Consumes water for water cooling (air system is more expensive)
- Intermittent technology and expandable

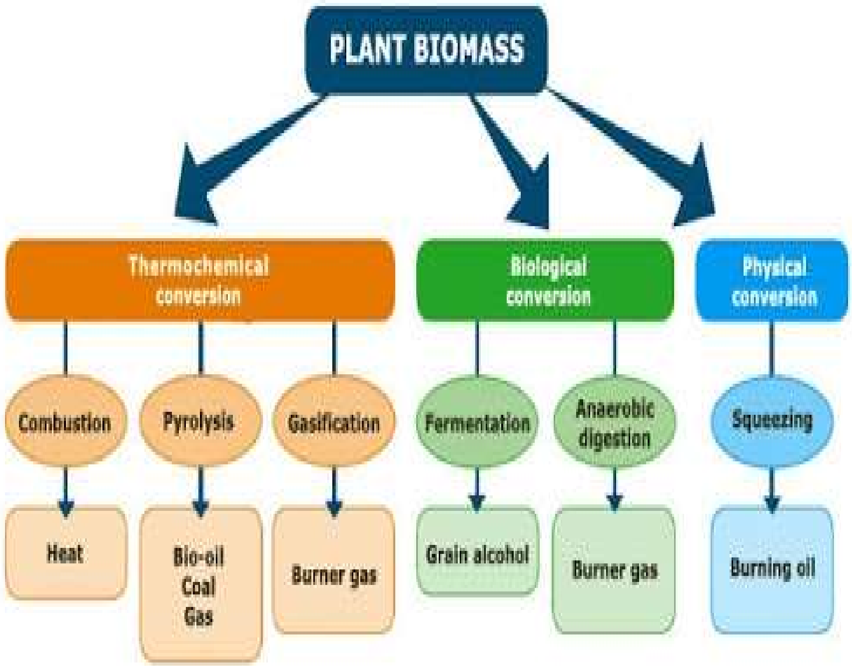
RENEWABLE ENERGY TECHNOLGIES
Photovoltaic Technology

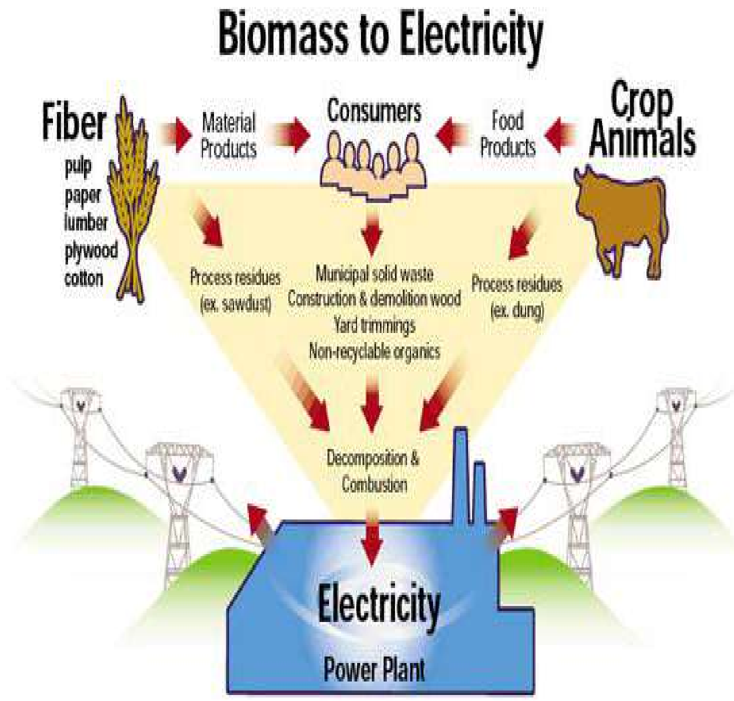


Source: IFC, 2015, p. 24

- Generating electric power by using solar cells to convert energy from the sun into a flow of electrons by the photovoltaic effect. Solar cells produce direct current electricity from sunlight which can be used to power equipment
- Carbon-free energy and consumes a lot of soil
- Intermittent technology and expandable

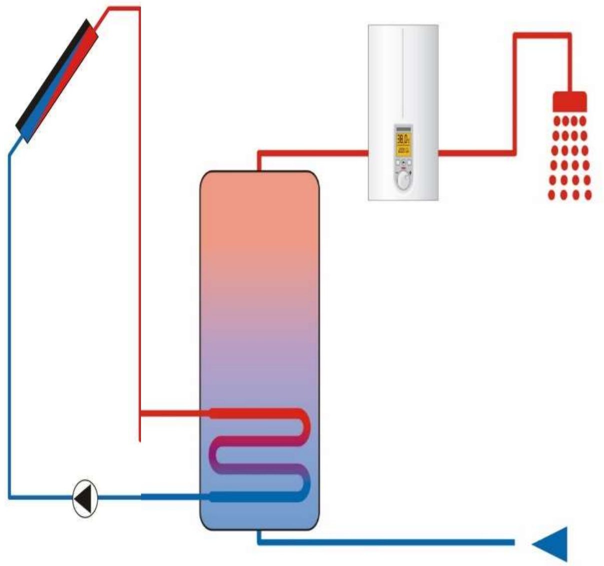
RENEWABLE ENERGY TECHNOLGIES
Biomass Technology





- It is plant or animal material used for energy production (electricity or heat), or in various industrial processes as raw substance for a range of products. It can be purposely grown energy crops (e.g. miscanthus, switchgrass), wood or forest residues, waste from food crops (wheat straw, bagasse), horticulture (yard waste), food processing (corn cobs), animal farming (manure, rich in nitrogen and phosphorus), or human waste from sewage plants
- There are three conversion technologies: thermochemical, biological and physical conversion

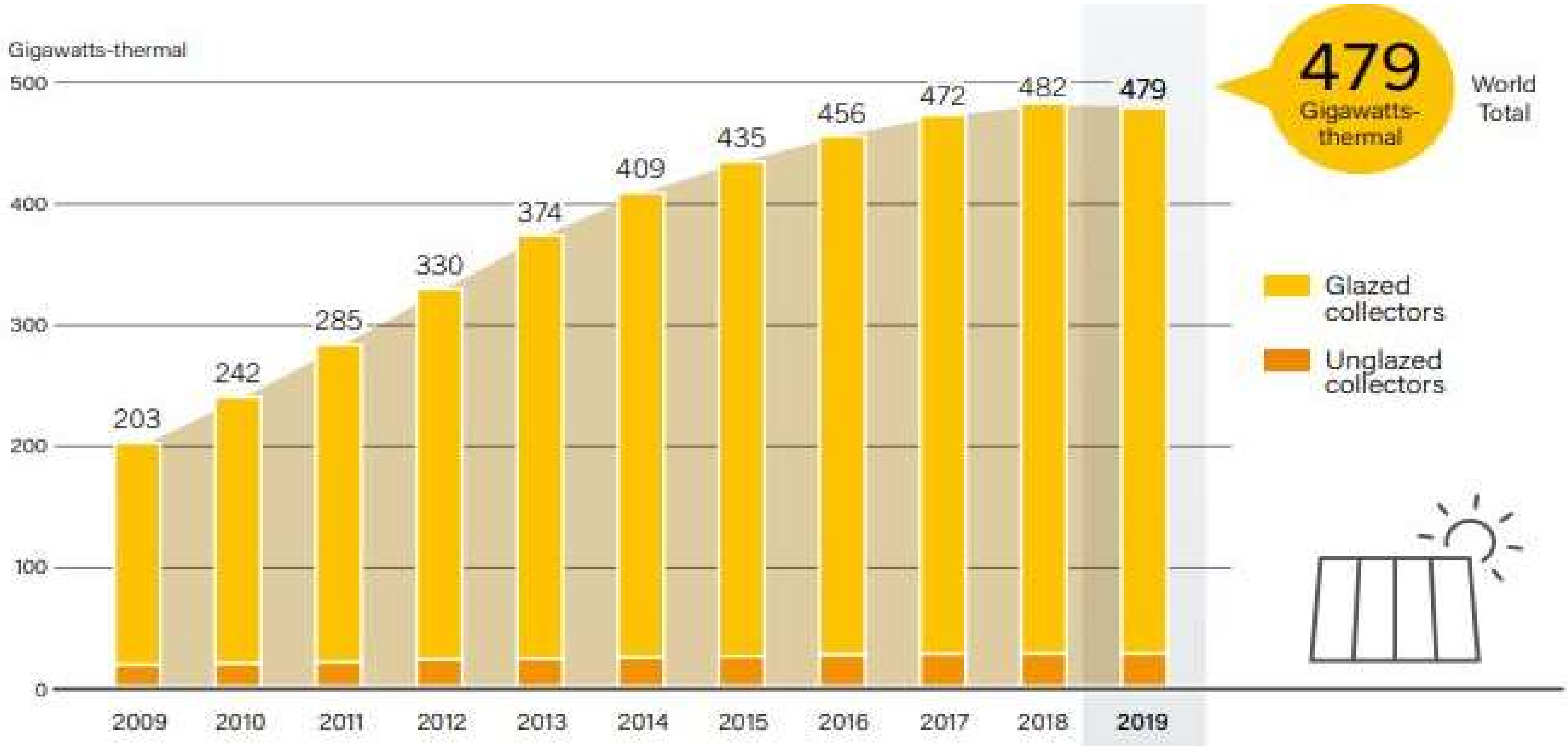
RENEWABLE ENERGY TECHNOLGIES
Solar thermal technology



- Use the sun energy to raise the temperature of a fluid to a useful temperature (example: heating domestic water at 45 °C)
- The temperature range can be as low as 25°C for a swimming pool up to 250°C to raise steam
- Carbon-free energy
- Intermittent technology and expandable

WORLD SOLAR THERMAL CONTEXT

Solar Water Heating collectors capacity



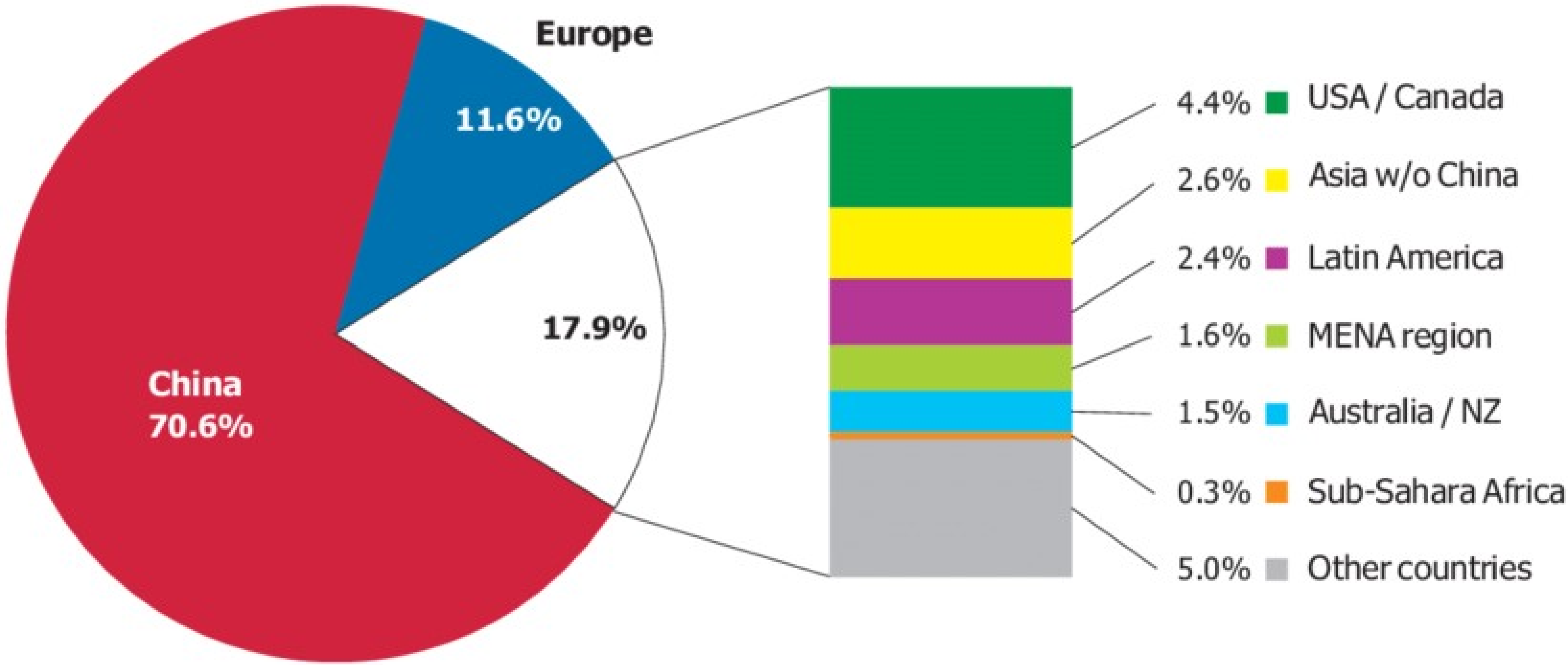
- ❑ An estimated of 479 GWth was installed by the end of 2019
- ❑ Glazed collectors cover 93% of the total market

Source REN21-2020

Need high resoultion picture
Yahia El-Masry, 03-Aug-20

YE2

WORLD SOLAR THERMAL CONTEXT
Share of the total installed capacity

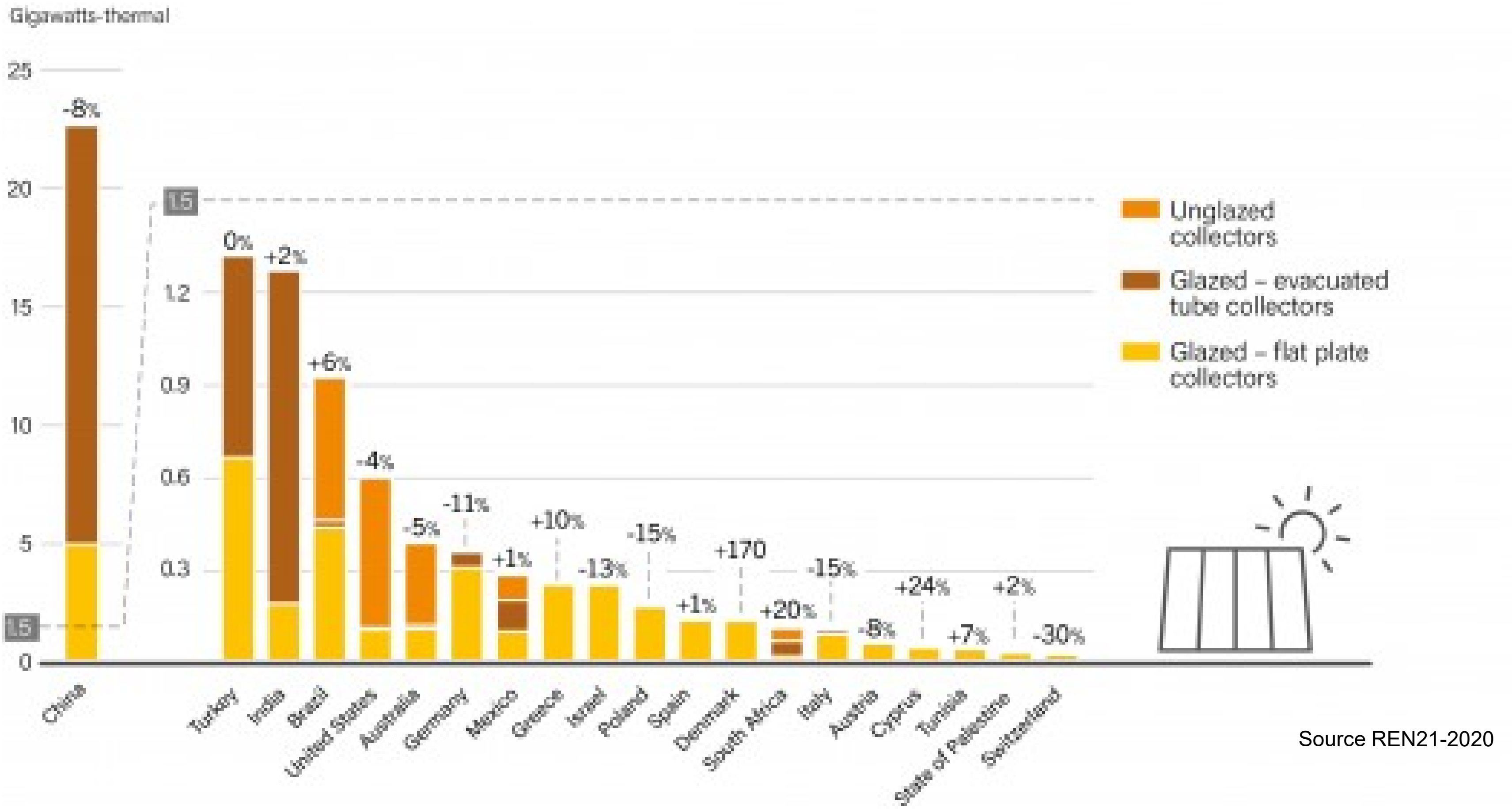


Sub-Sahara Africa:	Botswana, Burkina Faso, Cape Verde, Ghana, Lesotho, Mauritius, Mozambique, Namibia, Senegal, South Africa, Zimbabwe
Asia w / o China:	India, Japan, South Korea, Taiwan, Thailand
Latin America:	Argentina, Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 28, Albania, Northern Macedonia, Norway, Russia, Switzerland, Turkey
MENA countries:	Israel, Jordan, Lebanon, Morocco, Palestinian Territories, Tunisia

Source Solar Heat Worlwide -2019

The vast majority of the total capacity in operation was installed in China (334.5 GWth)

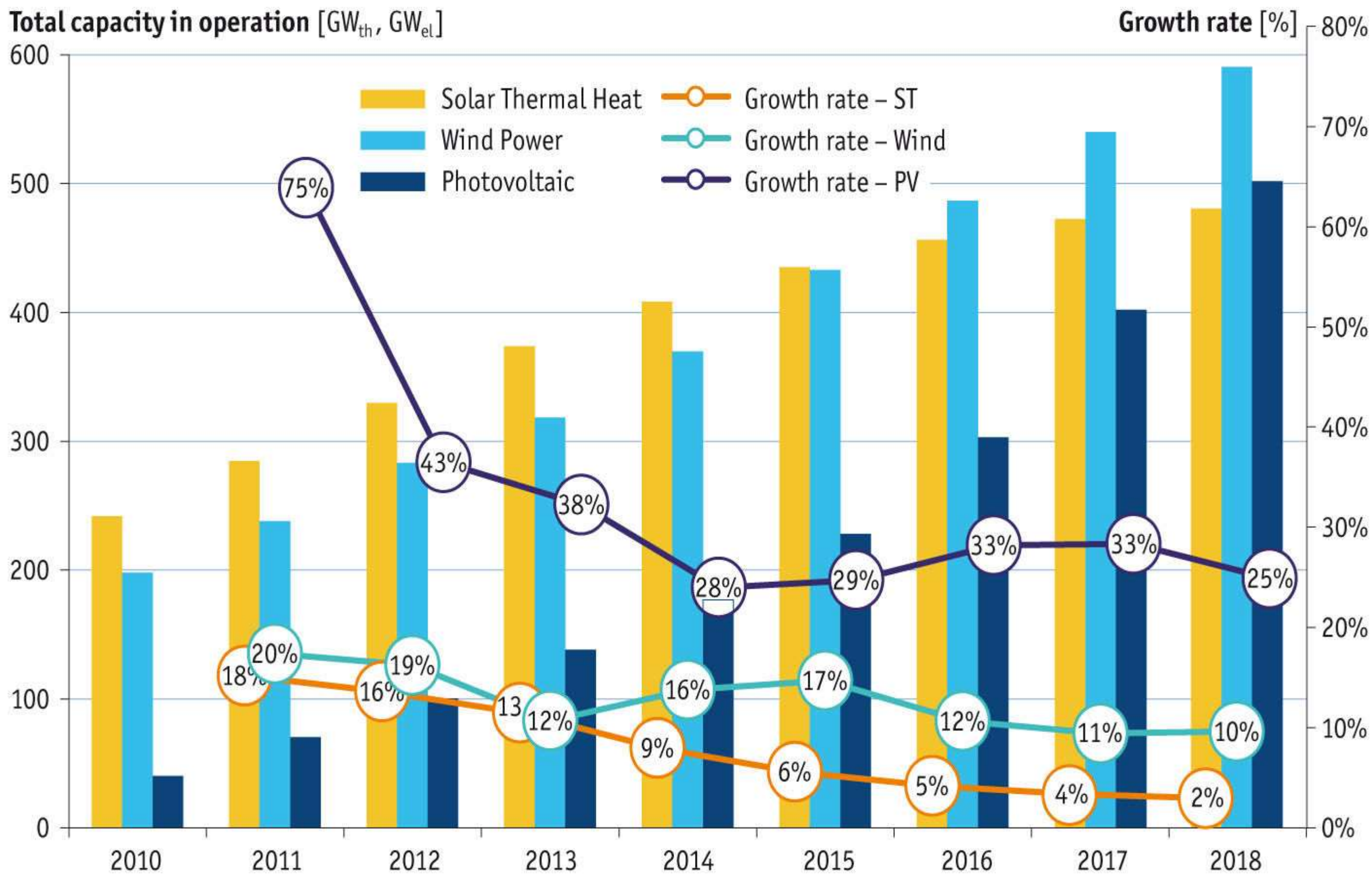
WORLD SOLAR THERMAL CONTEXT
Added capacity by country- 2019



Source REN21-2020

An estimated 31.3 gigawatts-thermal (GWth) of glazed (including flat plate and vacuum tube technology) and unglazed solar collectors was added globally in 2019

WORLD SOLAR THERMAL CONTEXT
Growth comparing to other technologies

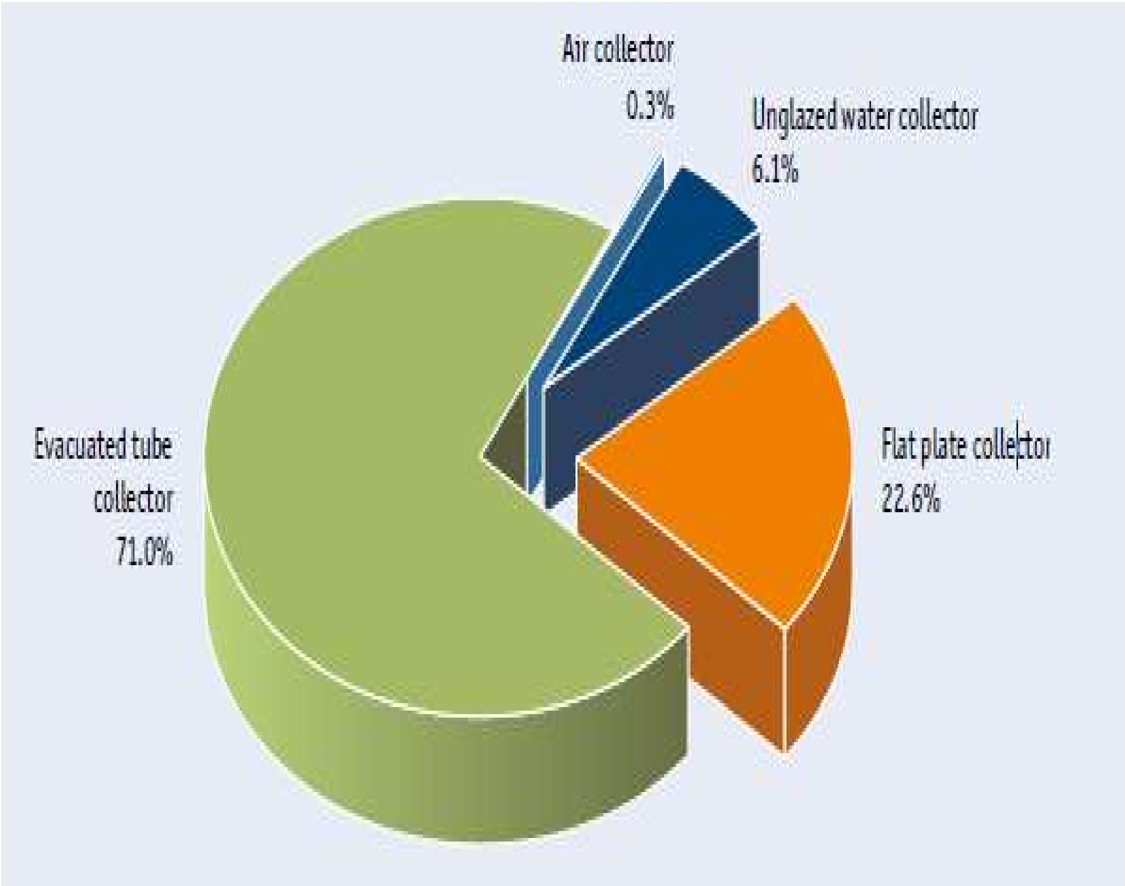


Solar thermal development stagnates compared to the other two technologies: Wind and Photovoltaic

Source: Solar Heat Worlwide -2019

WORLD SOLAR THERMAL CONTEXT

Total capacity distribution by collector type-2017

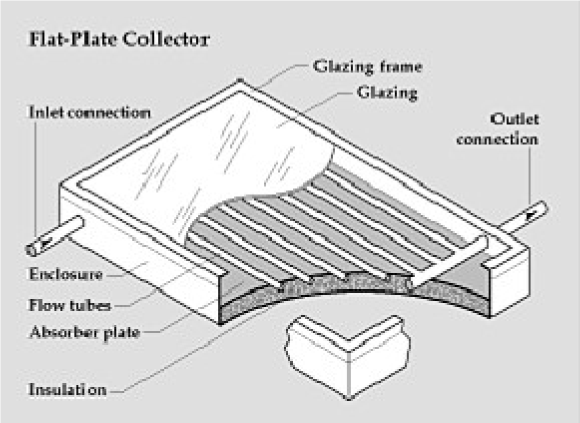


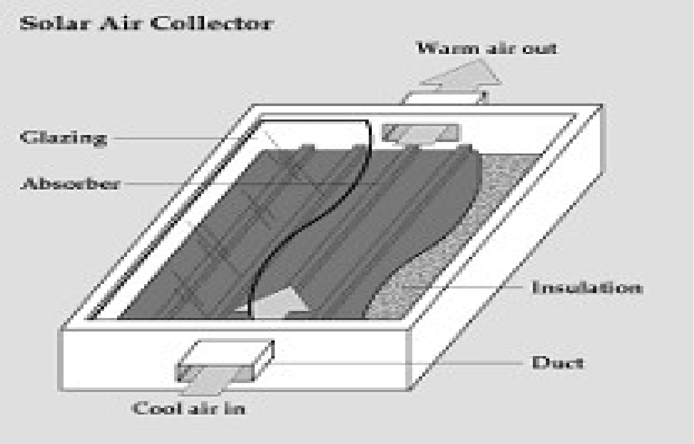
- **Air collector**: use solar radiation to actively deliver warm air into buildings
- **Unglazed water collector**: it's an absorber without glass and insulation
- **Flat plate collector**: is a device to collect solar energy and transform it into thermal energy (low-grade energy) by using water or antifreeze as a working fluid
- **Evacuated tube collector**: Consists of single tubes that are connected to a header pipe. To reduce heat losses of the water-bearing pipes to the ambient air, each single tube is evacuated

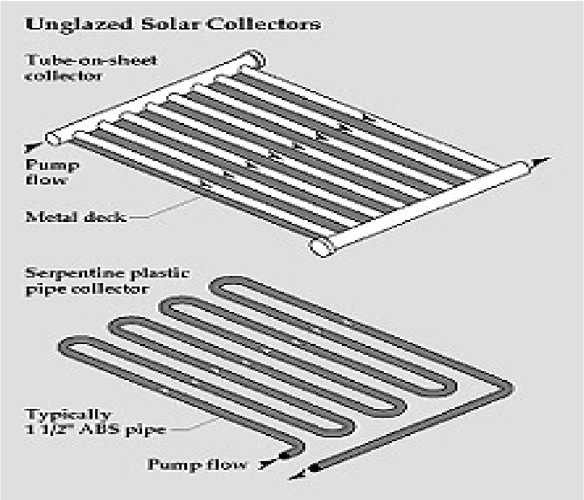
Source: Solar Heat Worlwide -2019

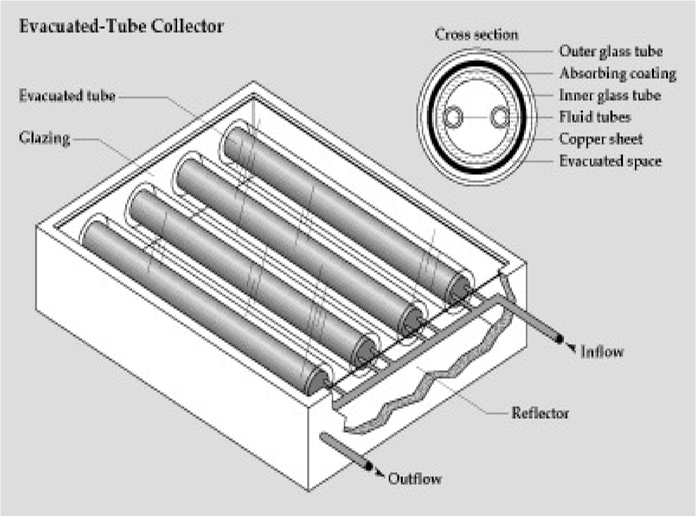
Evacuated tube collectors were the predominant solar thermal collector technology, followed by flat plate collectors with 22.6 %

WORLD SOLAR THERMAL CONTEXT
Technology collectors types



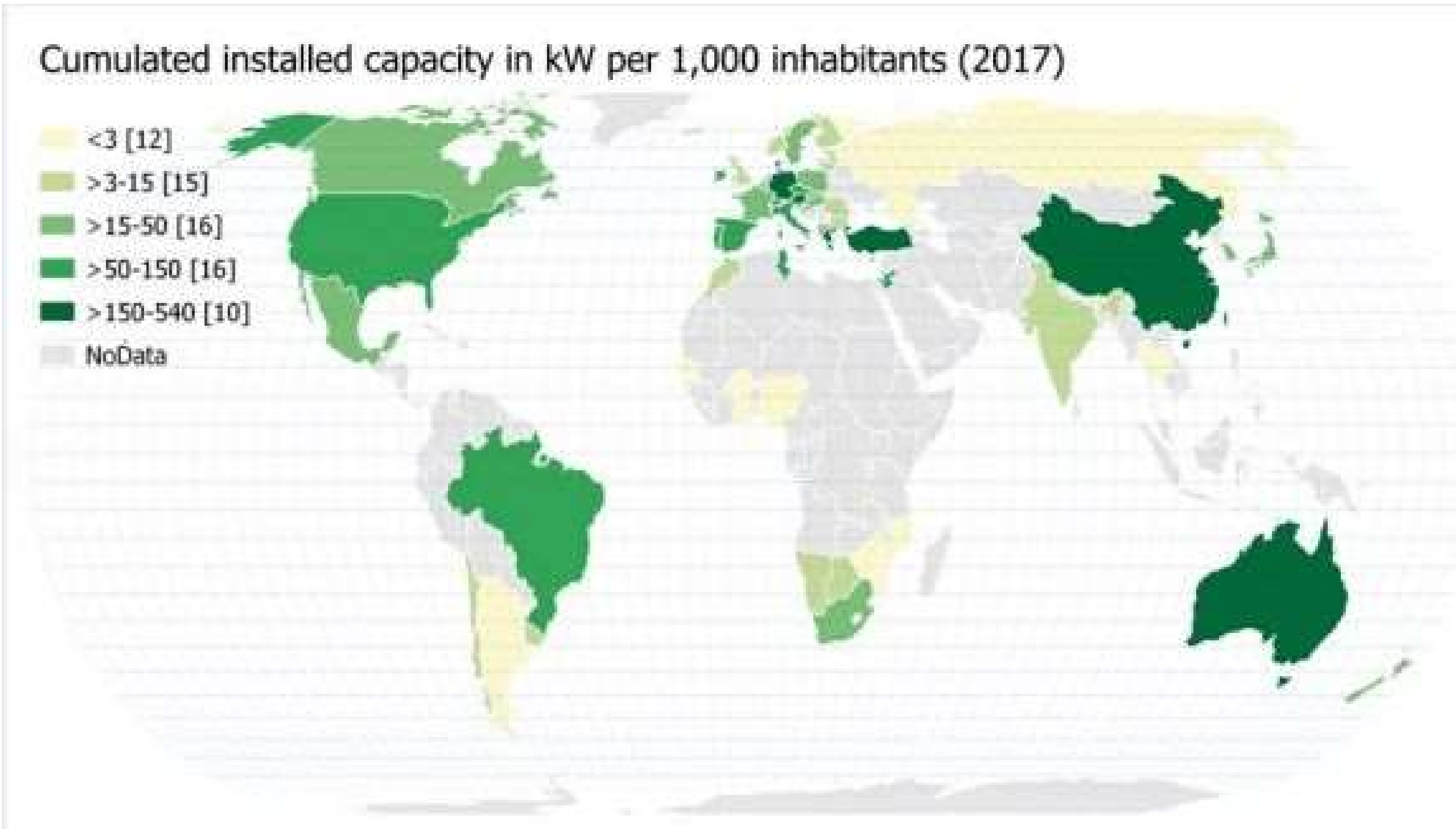






WORLD SOLAR THERMAL CONTEXT

Cumulated installed capacity in KW per 1000 inhabitant-2017

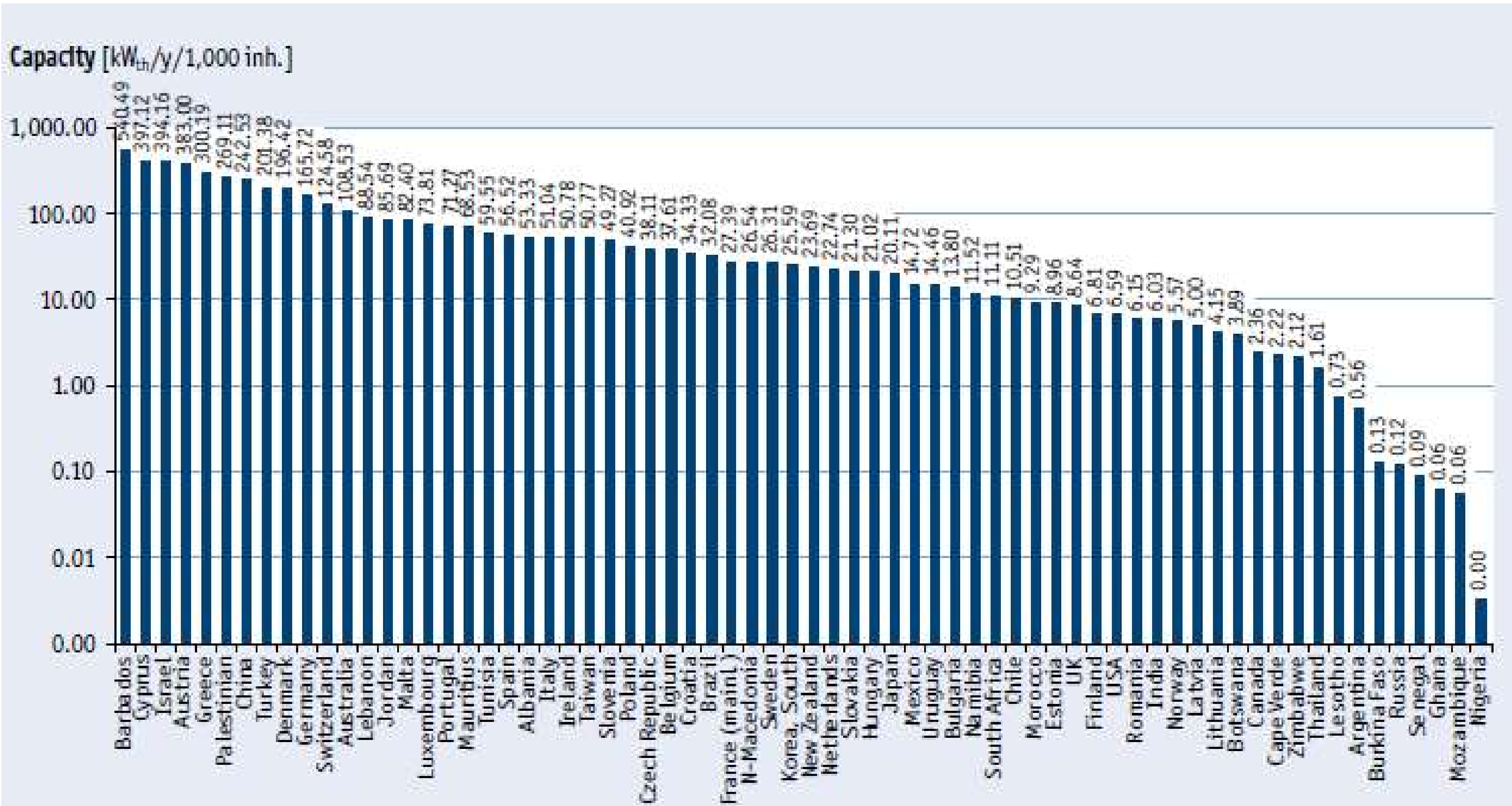


The main cumulated installed capacity concentration is in Asia (China), Australia and Europ

Source:Solar Heat Worlwide -2019

WORLD SOLAR THERMAL CONTEXT

Ranking of Cumulated installed capacity in KW per 1000 inhabitant for glazed collector-2017

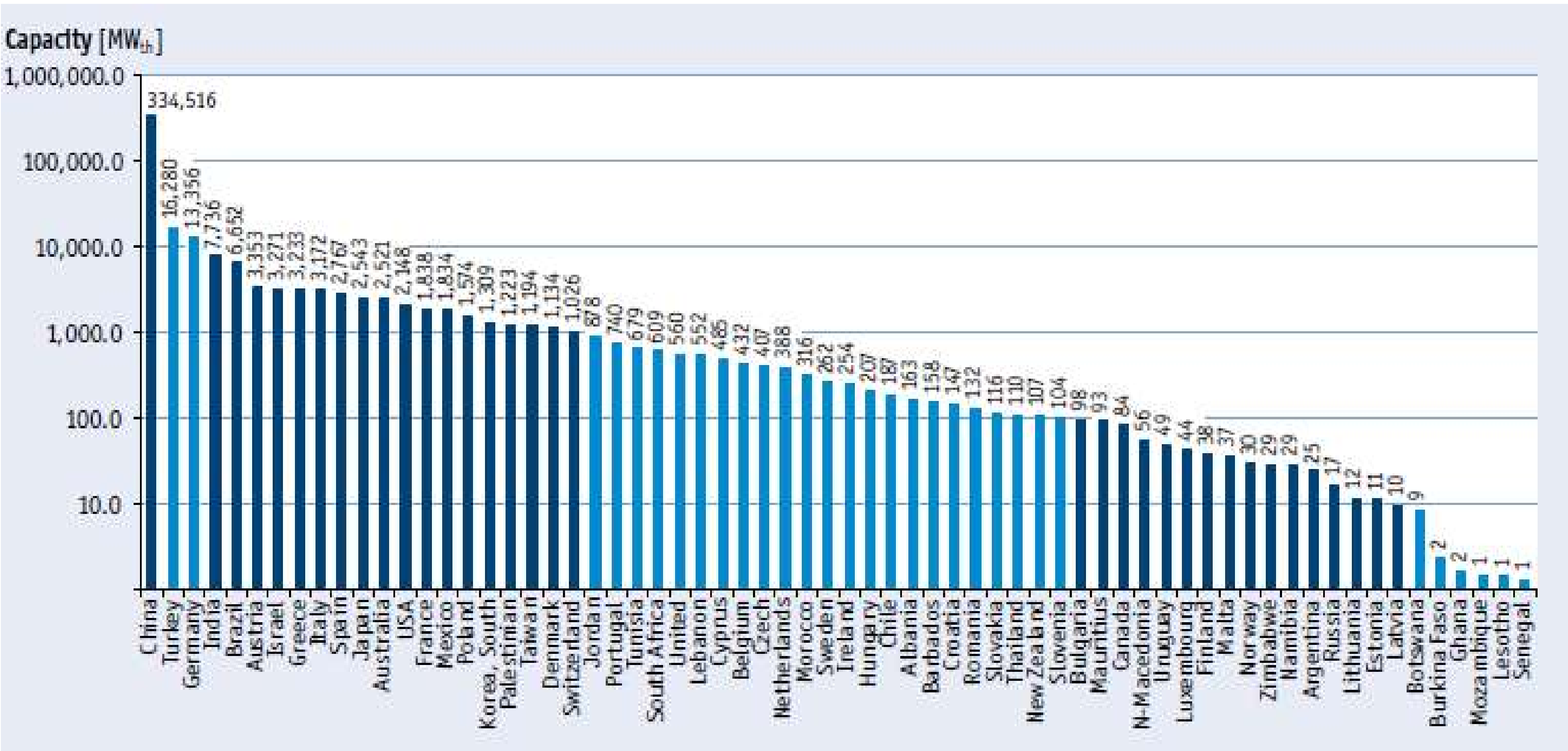


Lebanon is ranked the first arabic country with 85 kWth/y/1,000 inh

Source:Solar Heat Worlwide -2019

WORLD SOLAR THERMAL CONTEXT

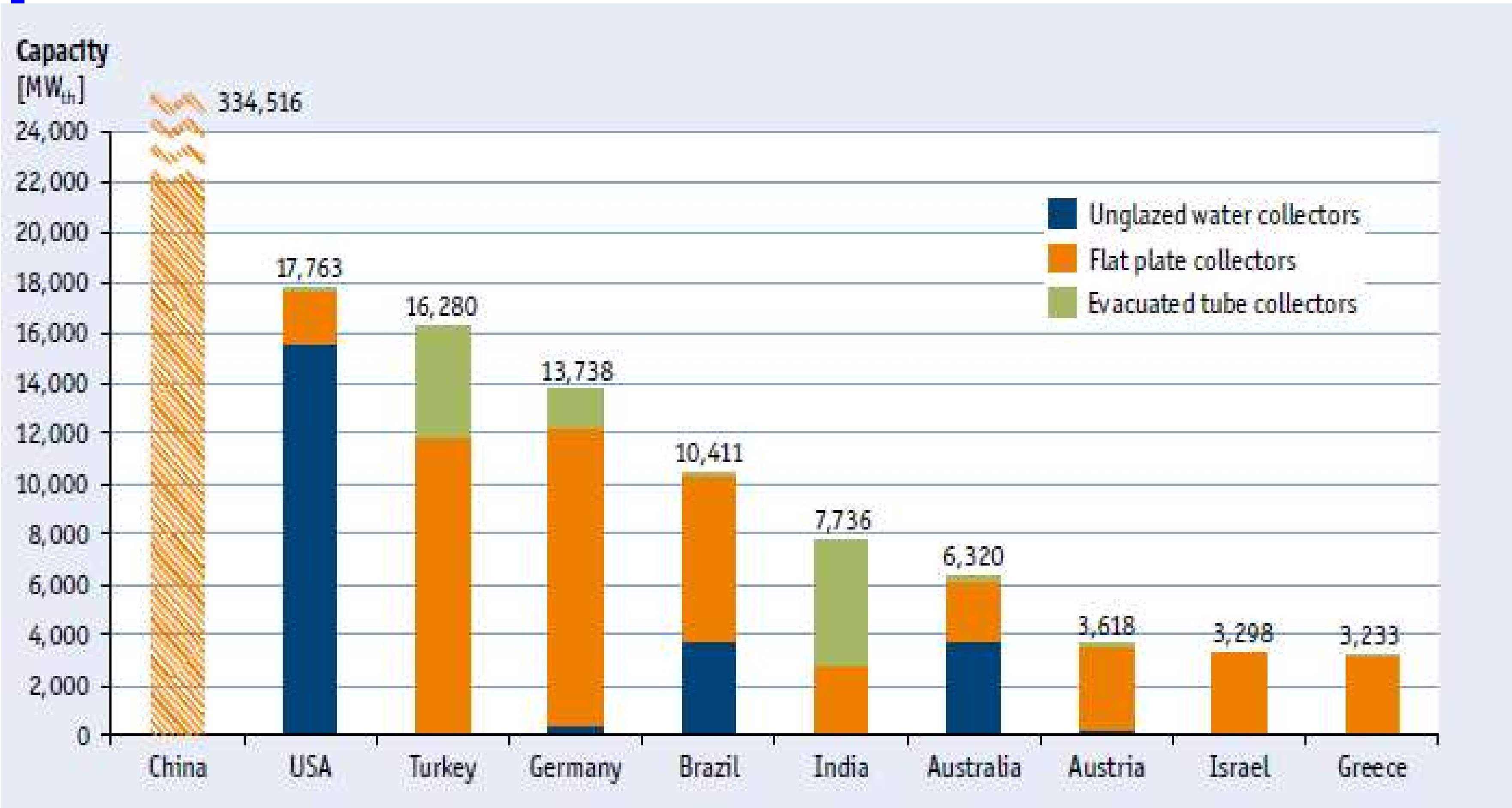
Ranking of cumulated installed capacity for glazed collector-2017



With 334.5 GWth, China was once again by far the leader in terms of total installed capacity of glazed water collectors in 2017

Source:Solar Heat Worlwide -2019

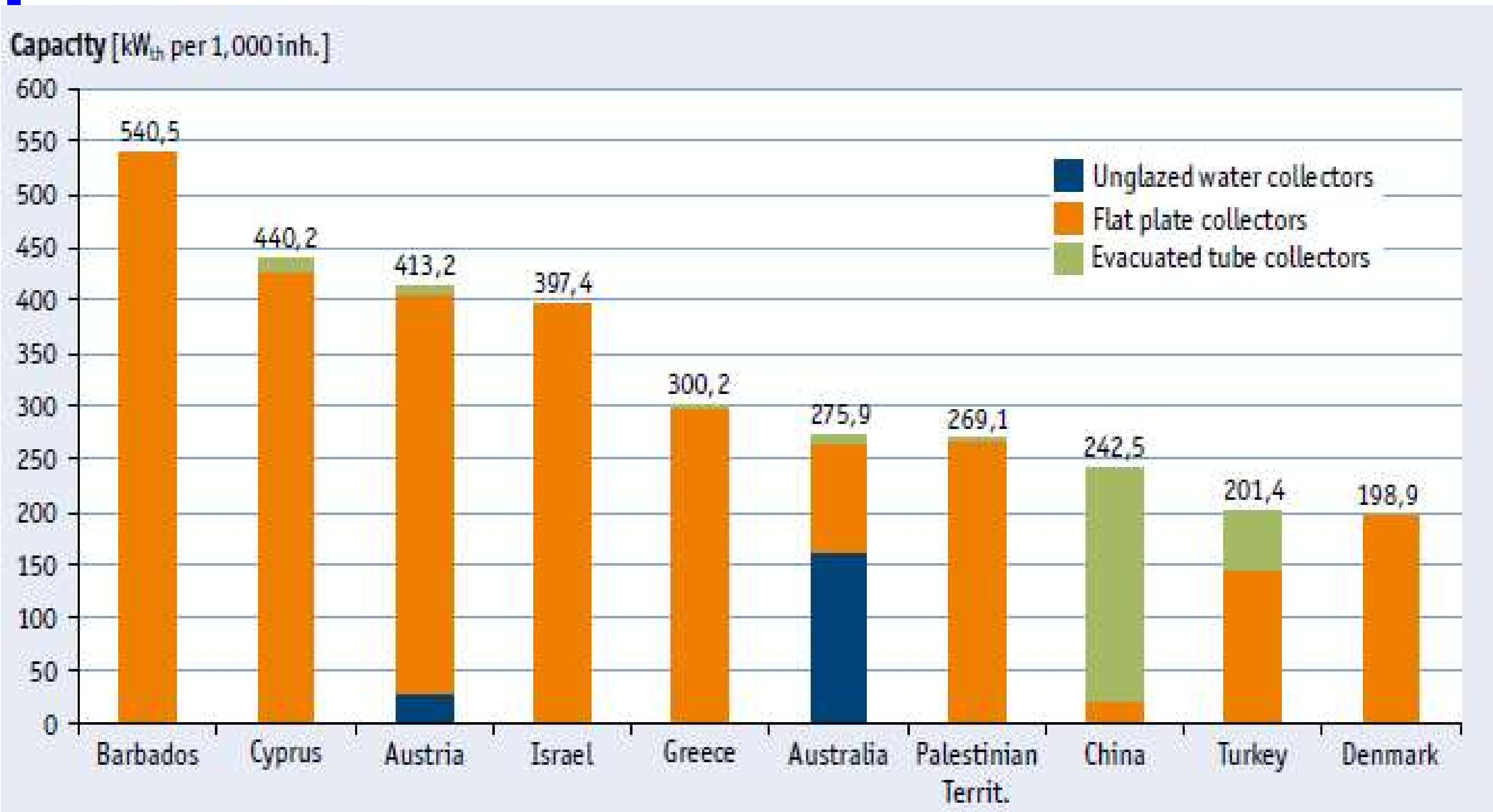
WORLD SOLAR THERMAL CONTEXT
Top 10 countries -2017



The United States market is dominated by
unglazed water collectors (swimming pool heating application)

Source:Solar Heat Worlwide -2019

WORLD SOLAR THERMAL CONTEXT
Top 10 countries per 1000 inhabitant-2017



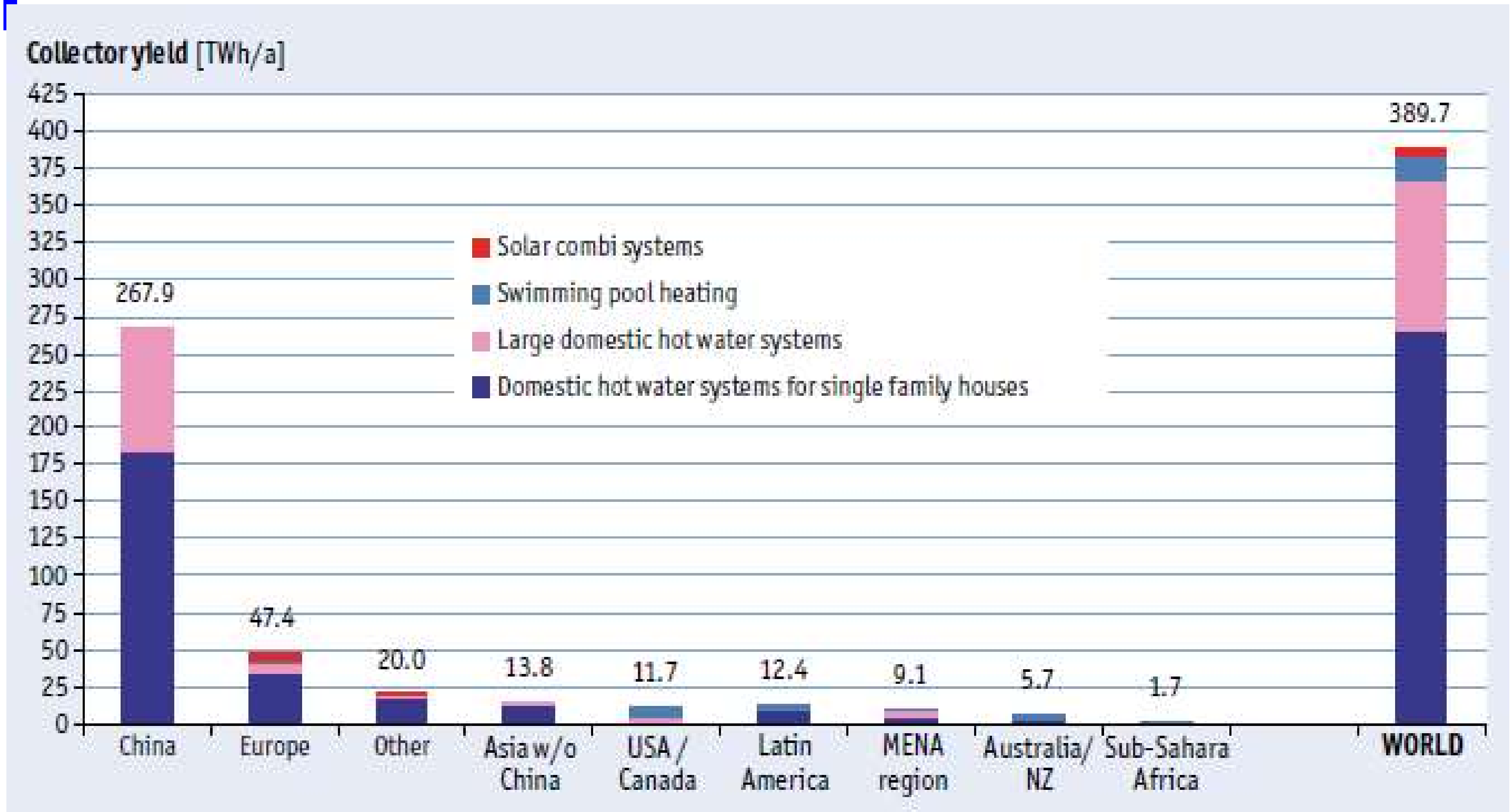
Barbados is the leader country in cumulated glazed and un glazed water collector capacity in operation in 2017 per 1,000 in habitants

Source:Solar Heat Worlwide -2019

YE13 YE14

WORLD SOLAR THERMAL CONTEXT

Annual collector yield by economic region-2017



Solar thermal collector yields amounted to 389.7 TWh worldwide and the major share, 68 %, was contributed by domestic hot water applications for single family houses

Source:Solar Heat Worlwide -2019

Need high resoultion picture **YE13**
Yahia El-Masry, 03-Aug-20

Need the statictics in the commerical and the industial **YE14**
Yahia El-Masry, 03-Aug-20

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SWH:
Solar radiation and orientation

Training of SWH installer & maintainer

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Solar Water Heaters
Solar radiation and orientation

Objective:

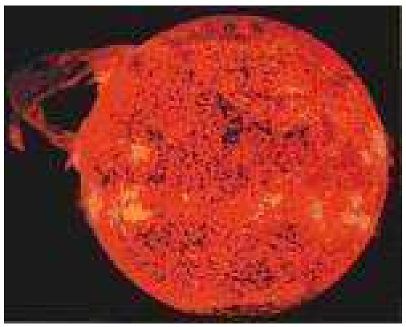
- ✓ Be informed on solar potential
- ✓ Have knowledge on solar thermal transformation
- ✓ How to get solar hot water?
- ✓ Why south is the best orientation for SWH?

Duration

- ✓ 0:30 hour
- ✓ From : 10:45 to 11:15
- ✓ Close phones
- ✓ Don’t speak to each other

Solar radiation & orientation

THE SUN

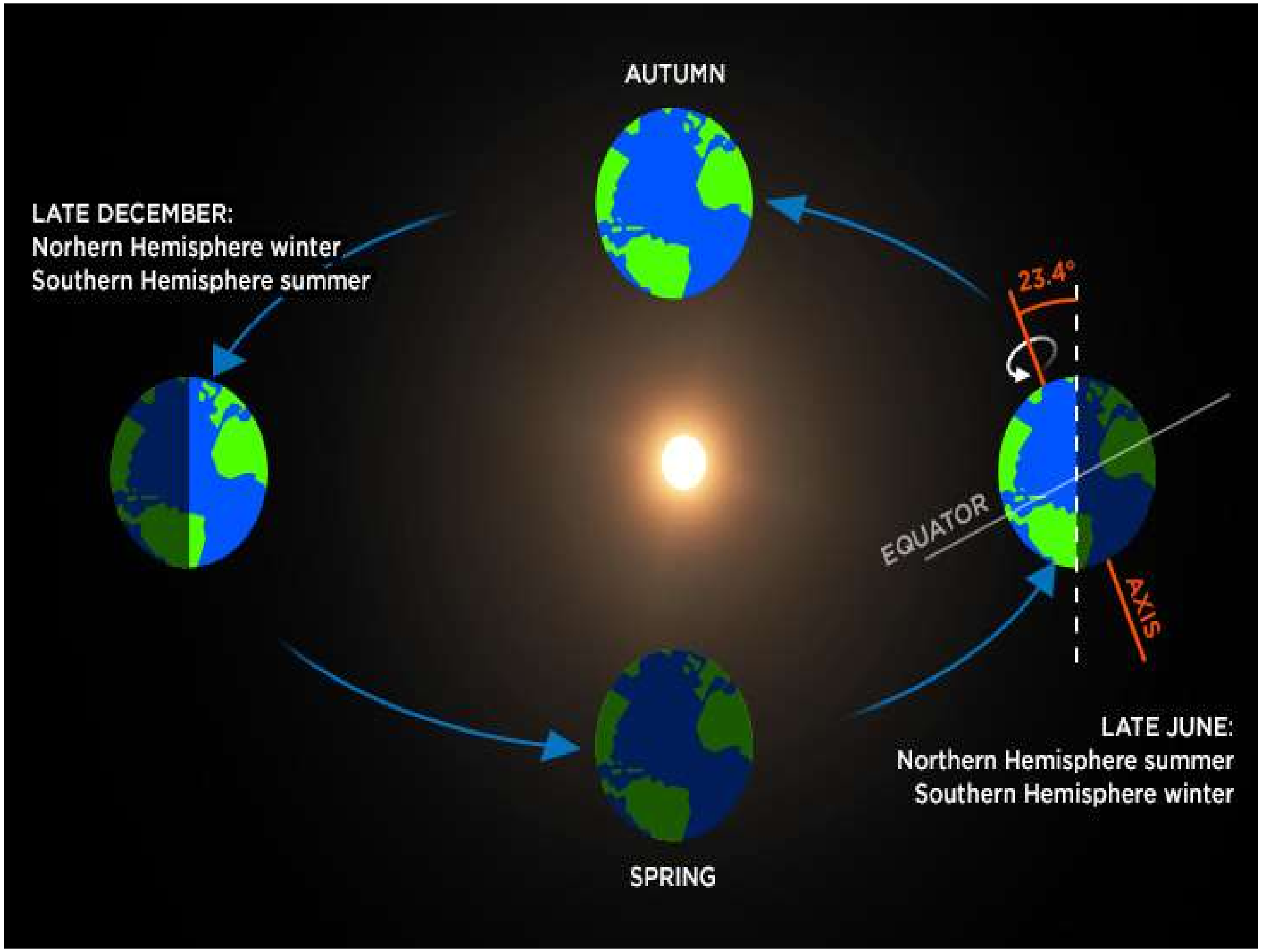


Principal characteristics	
Constitution	Helium (74%) Hydrogen (24%)
Average diameter	1 392 000 km (12 000 km for earth)
Mass	301,9891 x 10^{30} kg
Distance/Earth	150 000 000 km
Life expectancy	5 à10 milliards years
Actual age	4,5 milliards years

- Surface temperature is 5,760 K
- The irradiance is 1367 W / m²

Solar radiation & orientation
Earth's orbit around the sun

- The earth orbits around the sun describing an ellipse in 365 days and ¼
- The earth orbits around its own axis in 24 hours



Solar radiation & orientation
Sun quantity definition

- **Irradiance (G)** – is the radiant flux *received* by a *surface* per unit area. ***Power***
  - The SI unit is **W/m²**
- **Irradiation (H)** – The total quantity of energy incident on a surface
  - The SI unit is **kWh/m²**
- A clear and sunny day anywhere on earth
  - **Irradiance ≈ 1 000 W/m²**
  - **Irradiation ≈ 8 kWh/m²**
- **Solar irradiation** – the quantity of solar energy incident by the collector in a certain time
  - **kWh/day; kWh/year**
- **Specific solar irradiation** – the quantity of solar energy incident by 1 m^2 of collector surface in a certain time
  - **kWh/m²/day; kWh/m²/year**

Solar radiation & orientation
Calculation

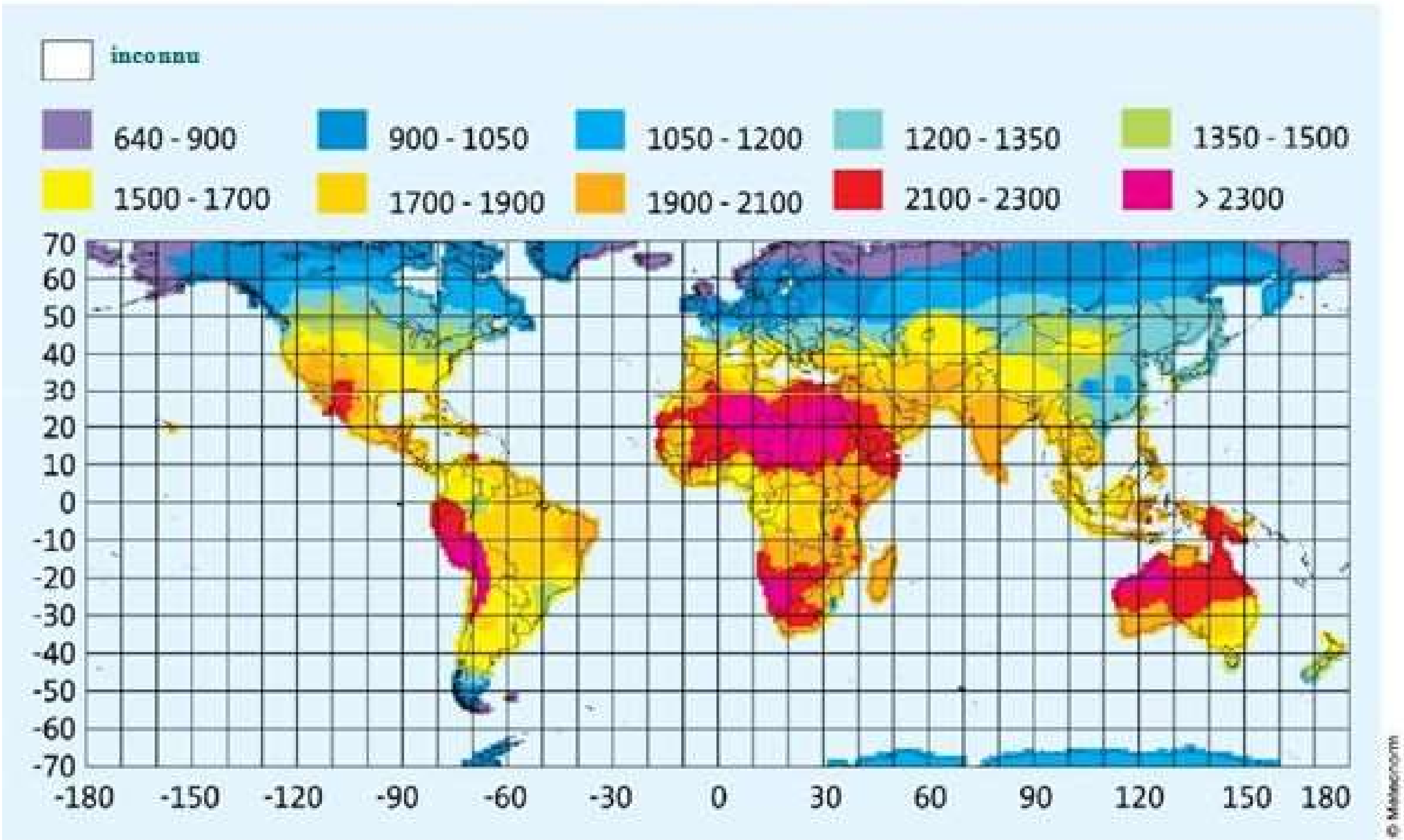
- ❑ The solar power incident on a surface averages 400 W/m2 for 12 hours. How much solar energy is received?

- ▪ 400 W/m2 x 12 hours = 4800 Wh/m2 = 4.8 kWh/m2

- ❑ The amount of solar energy collected on a surface over 8 hours is 4 kWh/m2. What is the average solar power received over this period?

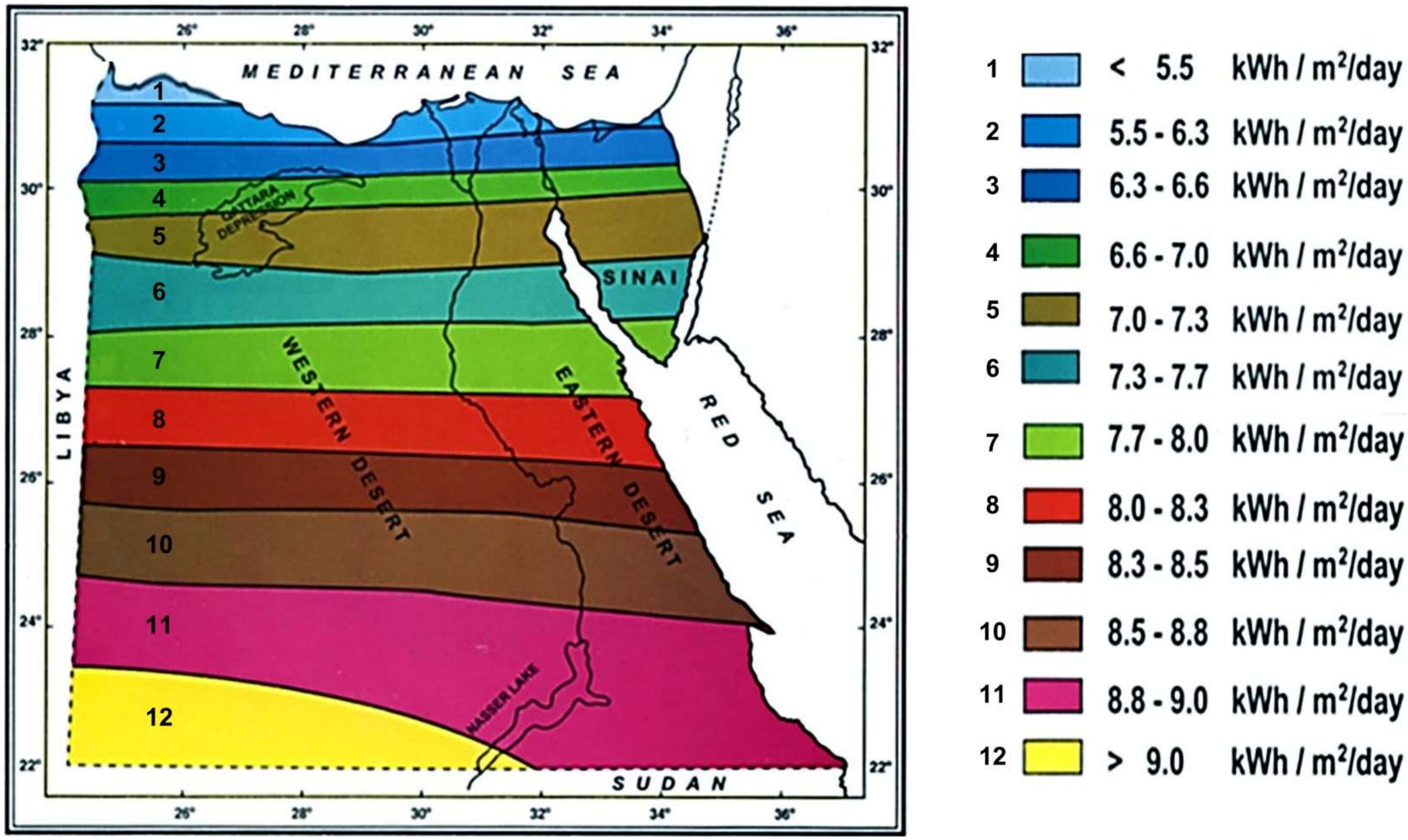
- ▪ 4 kWh/m2 / 8 hours = 0.5 kW/m2 = 500 W/m2

Solar radiation & orientation
World solar irradiation in KWh/m2/year



Best regions are : western and southern Africa, Australia, Peru and Chile with more than 2300 KWh/m2/year

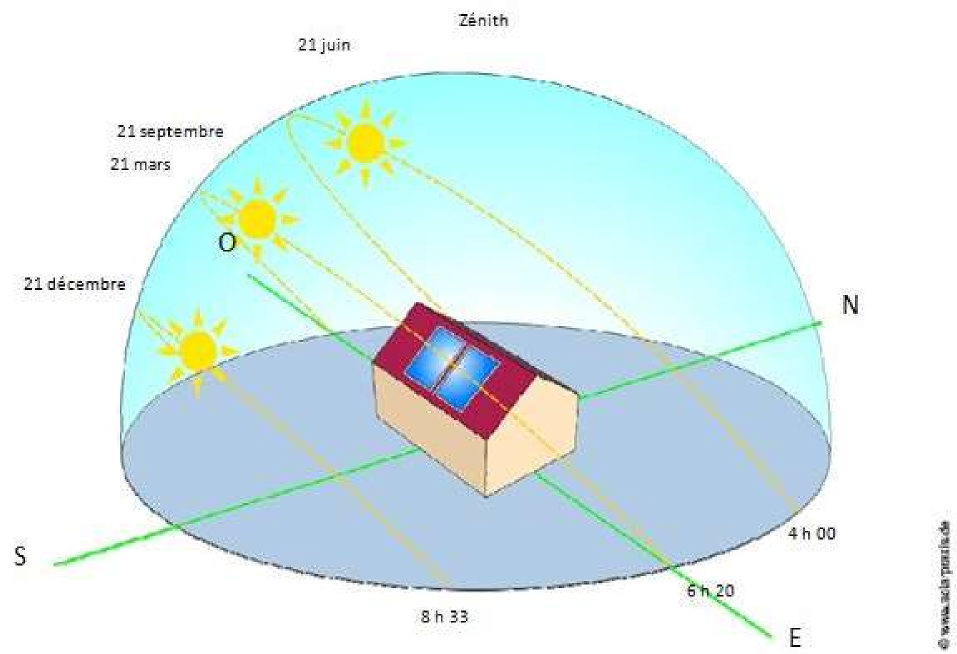
Solar radiation & orientation
Egyptian solar irradiation in KWh/m2/Day



Between 5 and 10 kWh / m² / day of average irradiation
3,200 hours of sunshine per year

Solar radiation & orientation
Geometry of the sun height

- **Sun average height:**
  21 mars / September = 90° - latitude
- **Sun maximum height:**
  21 June = 90° - latitude + 23.5°
- **Sun minimum height:**
  21 December = 90° - latitude – 23.5°
- **Collector average height = latitude**
- **Example : Cairo latitude = 30°**



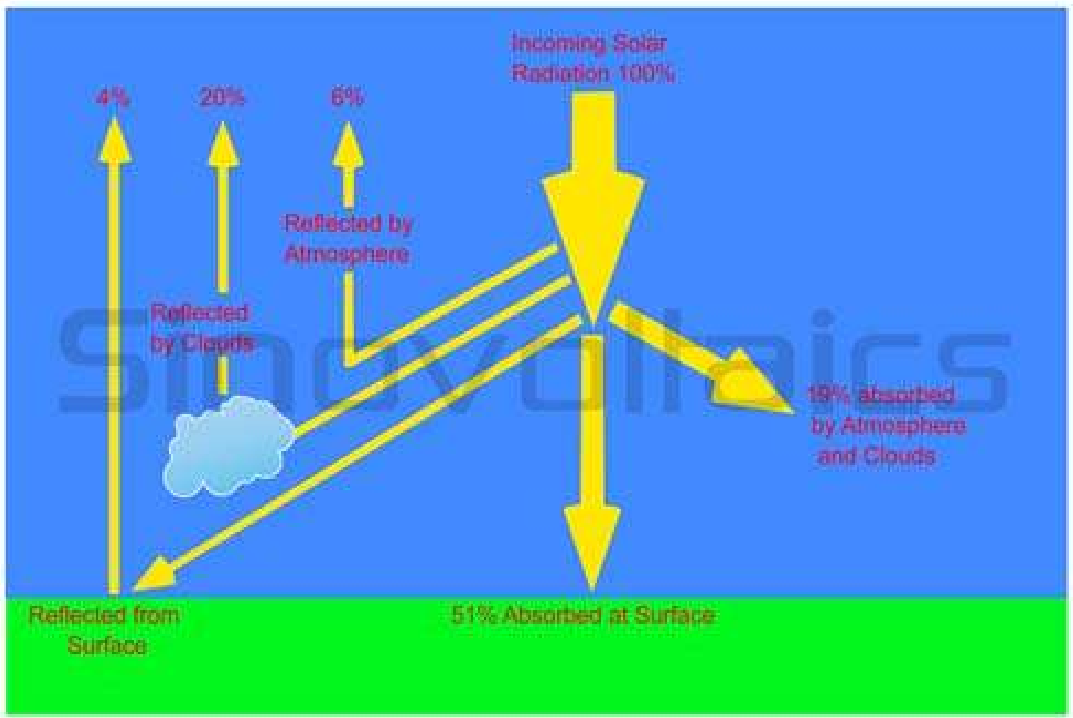
Solar radiation & orientation
Components of solar radiation

The total radiation is composed of the following three components:

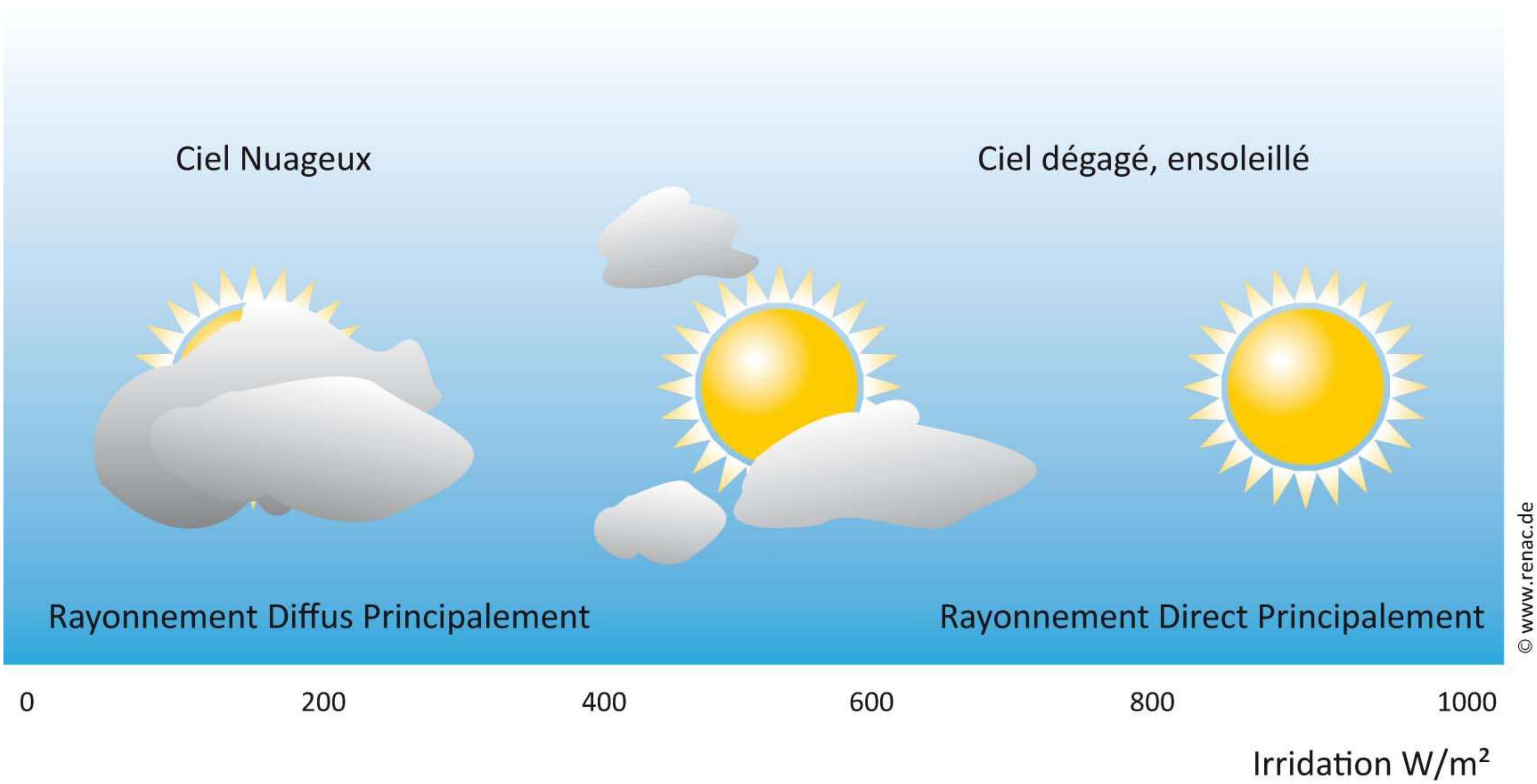
1.Direct Radiation (the radiation which comes directly from the sun)

2.Diffused Radiation (the radiation which is diffused by the sky, layers of atmosphere and other surroundings)

3.Reflected Radiation (the radiation which is reflected back by the lake, seas and other water bodies)



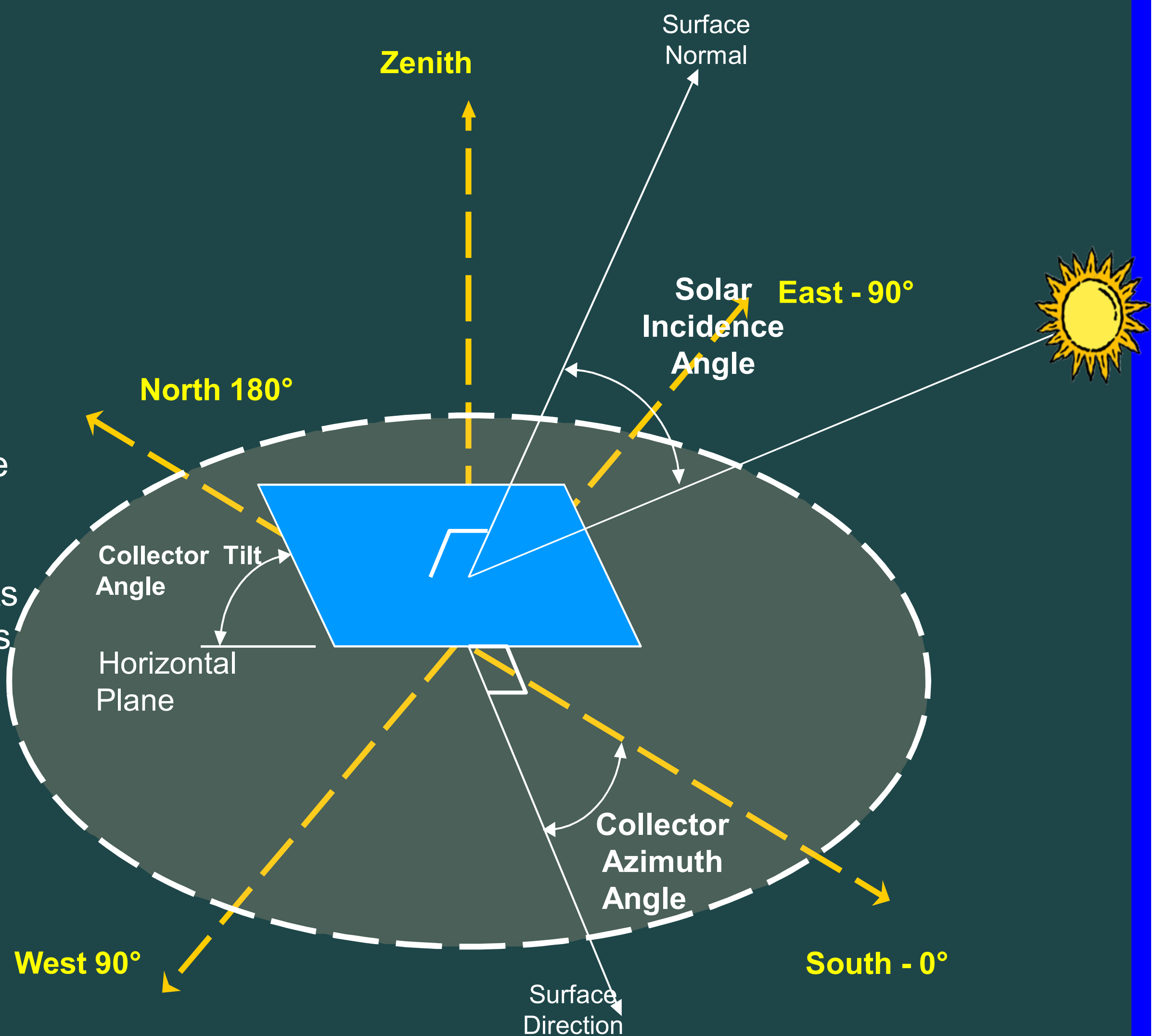
Solar radiation & orientation
Irradiation depends on climatic conditions



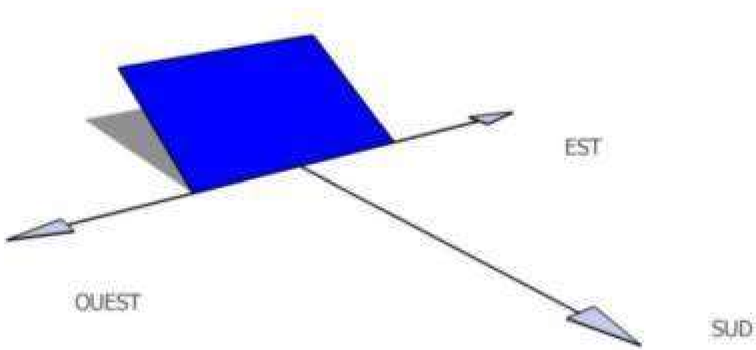
Example :For cloudy weather, the solar irradiation is about 200 W/m2

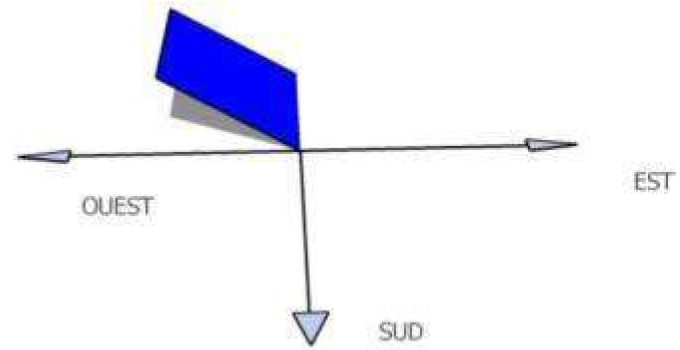
Solar radiation & orientation
Collector orientation

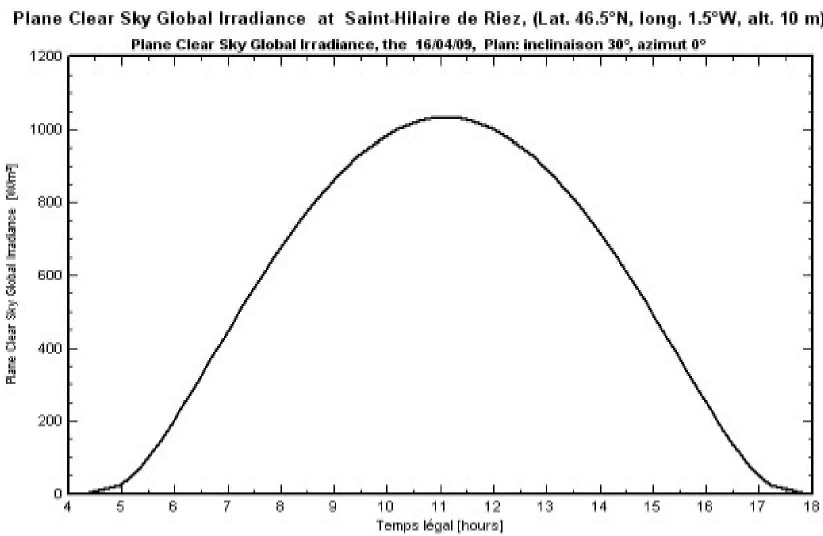
- **The orientation of solar collectors is defined by two angles with respect to the earth's surface.**
- **The *collector azimuth angle*** represents the angle between due geographic south and direction the collector faces.
- **The *collector tilt angle*** represents the angle the array surface makes with the horizontal plane.
- **The *solar incidence angle*** represents the angle between the sun's rays and the normal (perpendicular) to a collector surface.

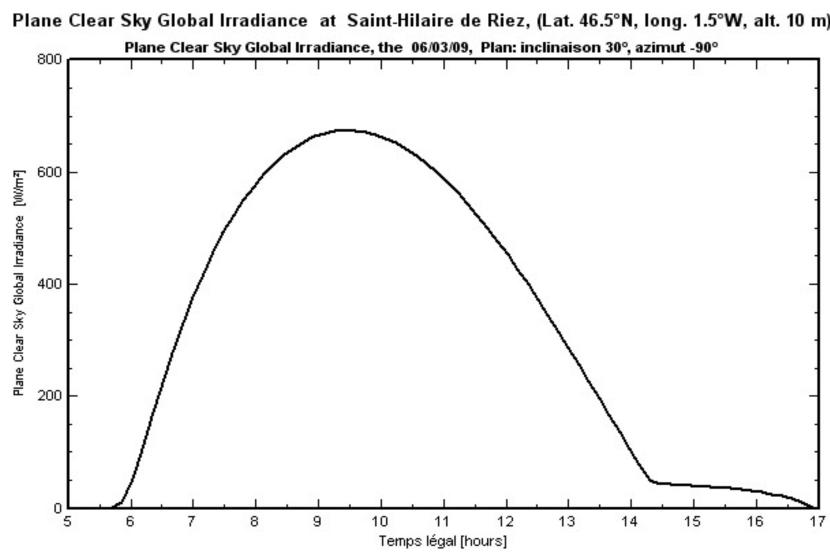


Solar radiation & orientation
Irradiation depending on orientation









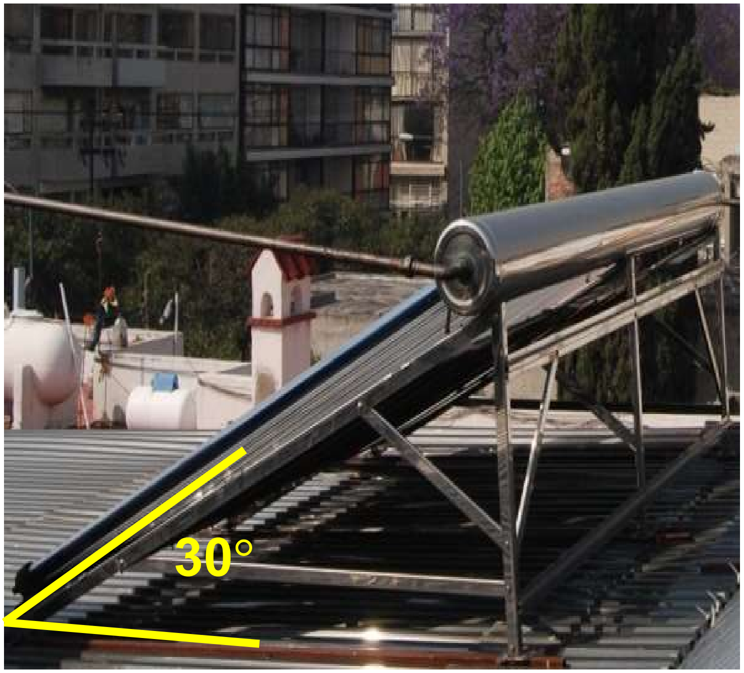
South orientation offers a better solar irradiation distribution throughout the day

Solar radiation & orientation
Optimum of azimuth and collector tilt angle

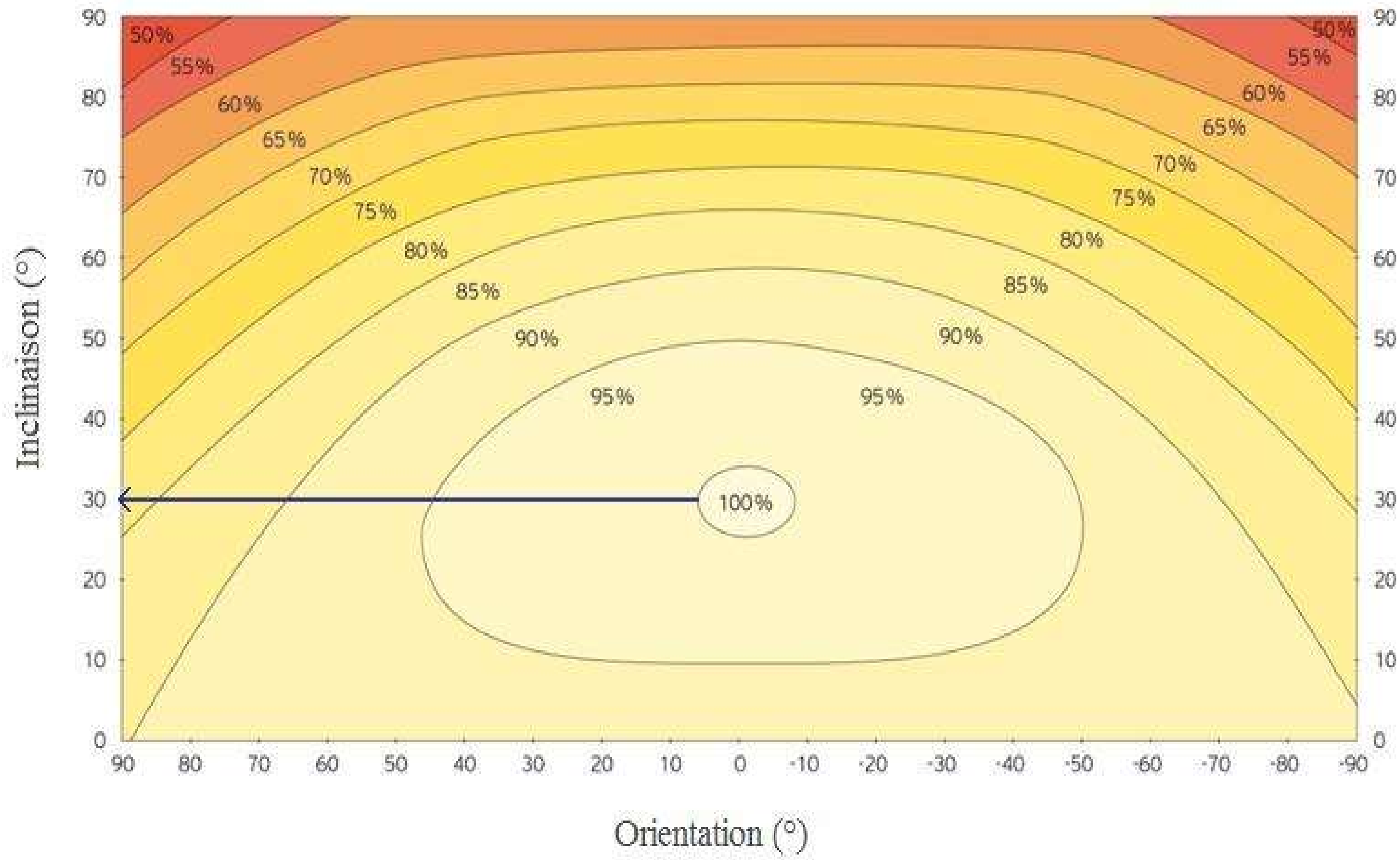
- ❑ In the Northern Hemisphere, the optimal orientation is facing south: **Azimut 0°**
- ❑ Optimal collector tilt angle = **latitude angle**
- ❑ Optimal collector tilt angle depends on the time of the year during which hot water is needed
- ❑ **Example : Cairo case**

✓ Latitude : 30° - Optimal collector tilt angle : 30°

✓ Azimuth : 0°

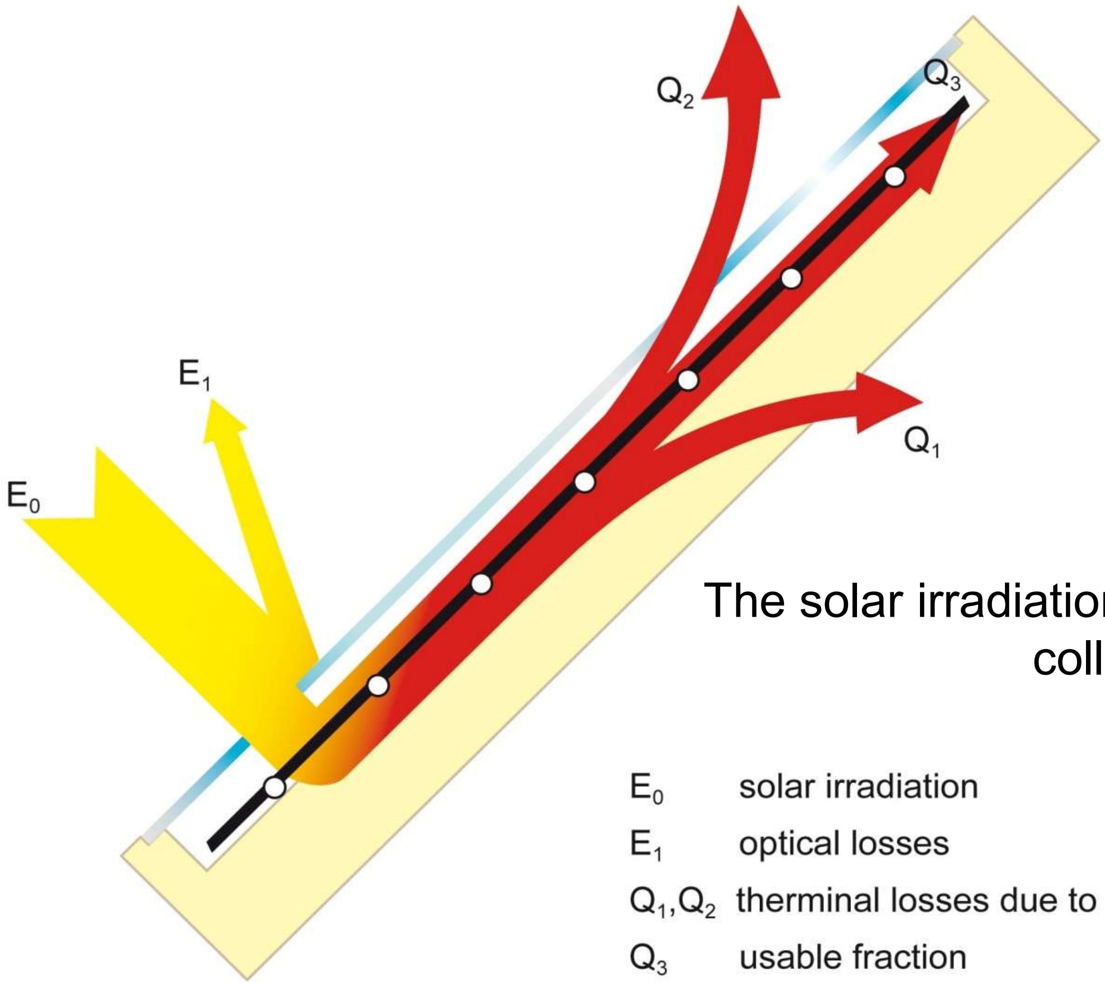


Solar radiation & orientation
Optimum of azimuth and collector tilt angle along the year



30 ° inclination and south orientation offer maximum correction factor(100%)

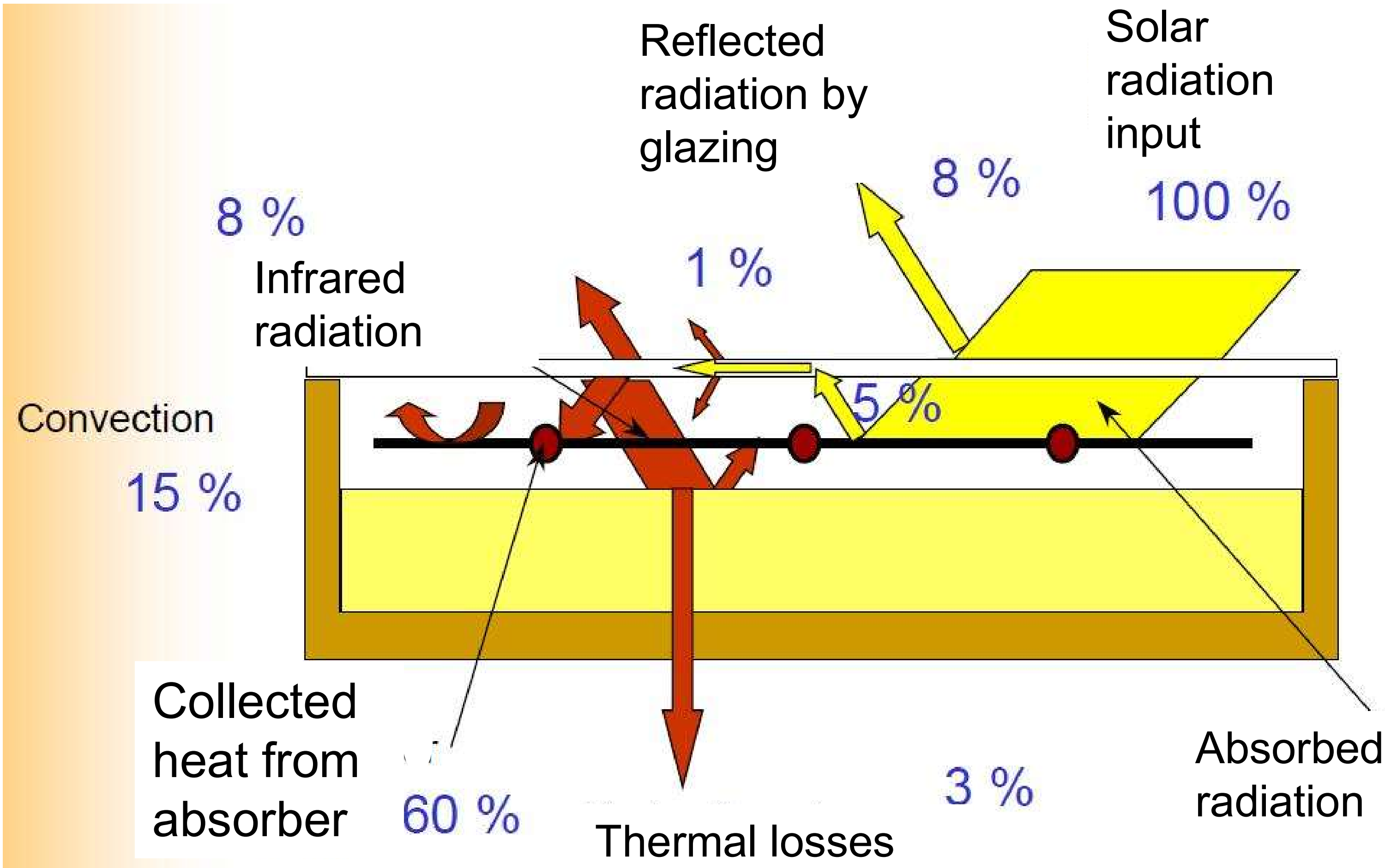
Solar radiation & orientation
How to get solar energy?



The solar irradiation quantity absorbed by the collector is Q3

E_0	solar irradiation
E_1	optical losses
Q_1,Q_2	therminal losses due to convection and conduction
Q_3	usable fraction

Solar radiation & orientation
Heat losses



The total thermal losses for a collector are about 40 %

Conclusion

- The solar radiation received on earth is affected by the earth's movements and atmospheric conditions.
- The irradiation depends on orientation and inclination
- The optimal orientation is facing south (azimuth 0°)
- The optimal collector tilt angle is the latitude of the location

- **Need to identify the best orientation before SWH installation**
- **Need to identify the inclination of the collector according to the country**

SWH: Definitions and technologies

Training of SWH installer & maintainer

Solar Water Heaters
Definition and technologies

Objective:

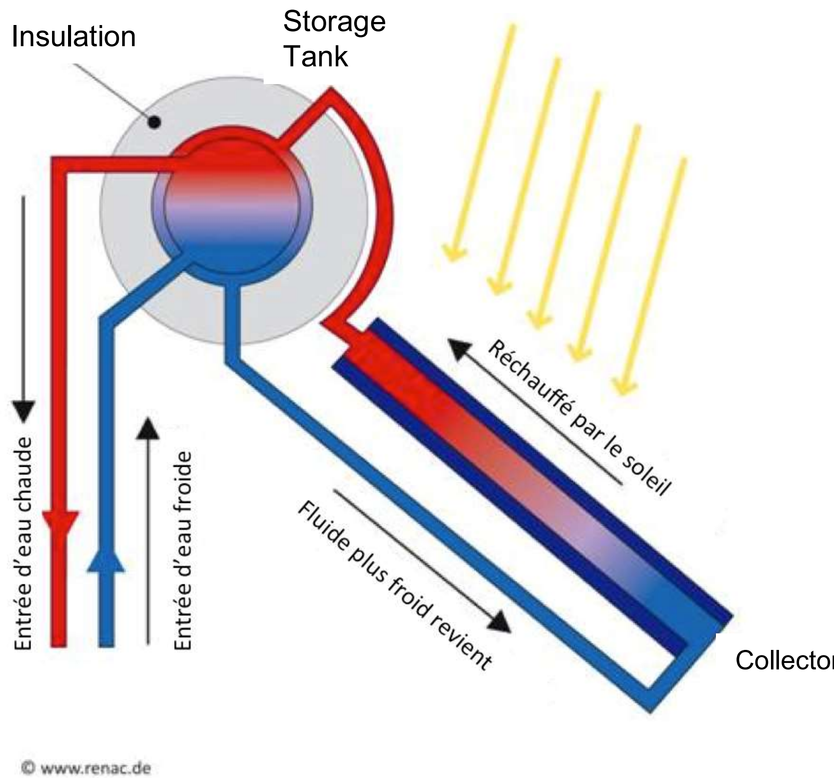
- ✓ Be informed on SWH components
- ✓ Have knowledge on main SWH typologies
- ✓ Have detailed definition of SWH types
- ✓ How SWH is designed?

Duration

- ✓ 1:15 hour
- ✓ From : 11:15 to 12:30
- ✓ Close phones
- ✓ Don’t speak to each other

SWH TECHNOLGY
SWH Components

- Collector
- Tank
- Accessories
- Connecting pipework

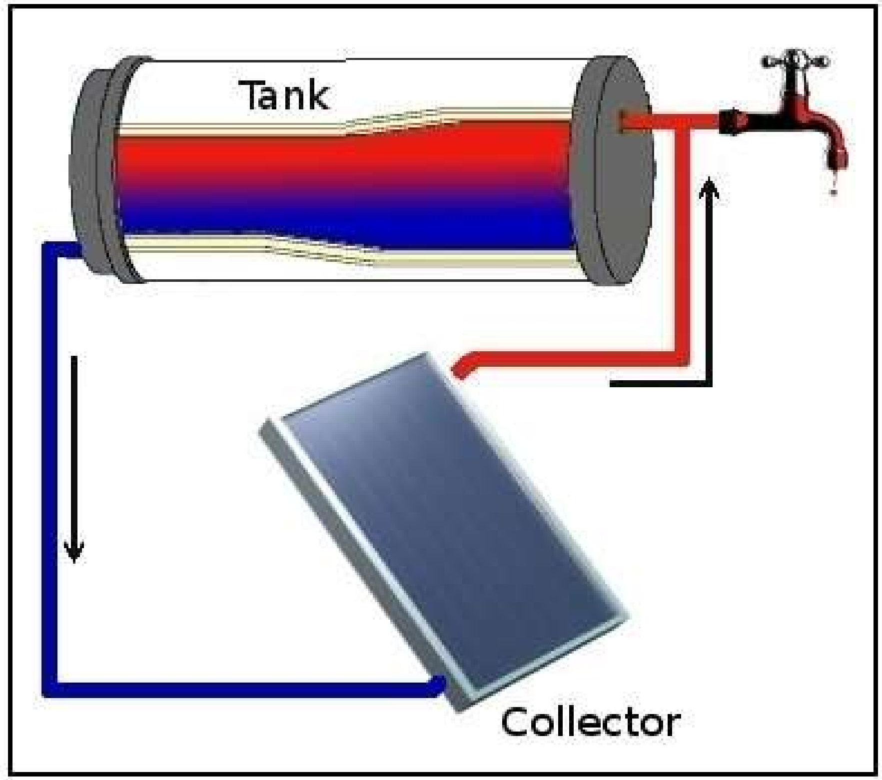


SWH TECHNOLGY
SWH system types

- Thermosiphon direct system (open loop system)
- Thermosiphon indirect system (close loop system)
- Forced circulation system

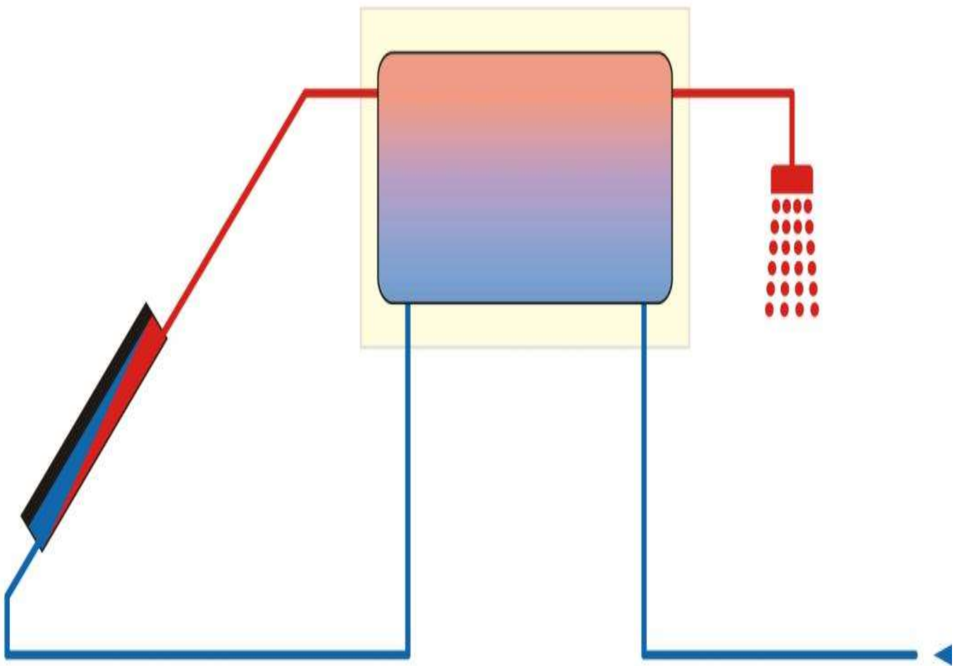
SWH TECHNOLGY
SWH Typology : Thermosiphon principle

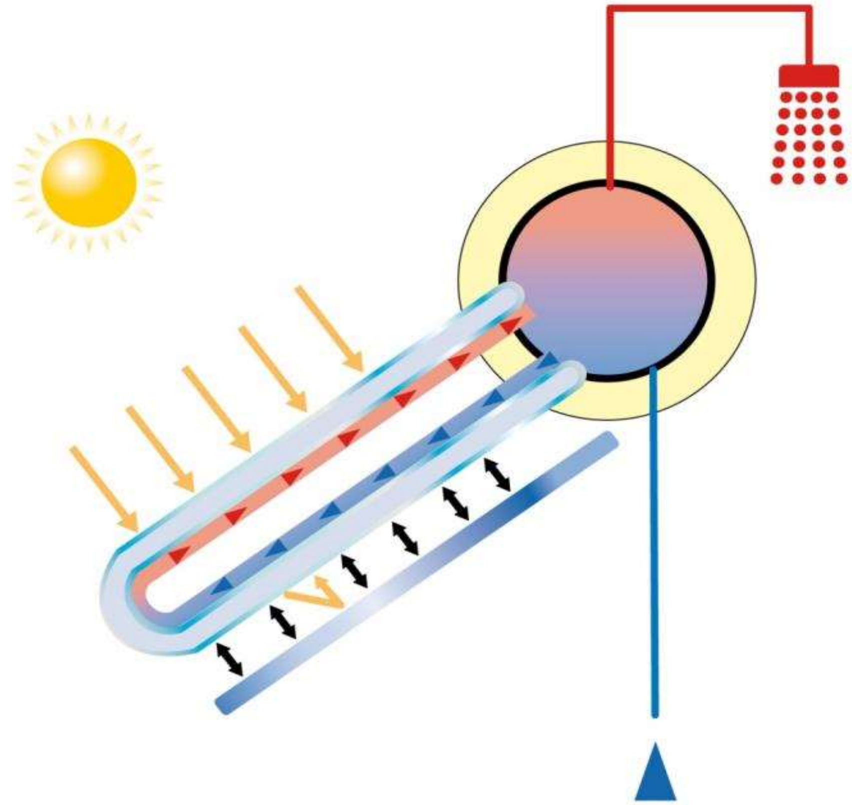
- The heated water rises up into the storage tank by natural Thermosiphon action
- Water which is heated in the collectors expands becoming lighter allowing colder heavier water to fall by gravitational force to the bottom of the collector
- The cold water pushes the hotter lighter water back up into the storage tank.



Thermosiphon action occurs without any moving parts or auxiliary electrical energy input to the system

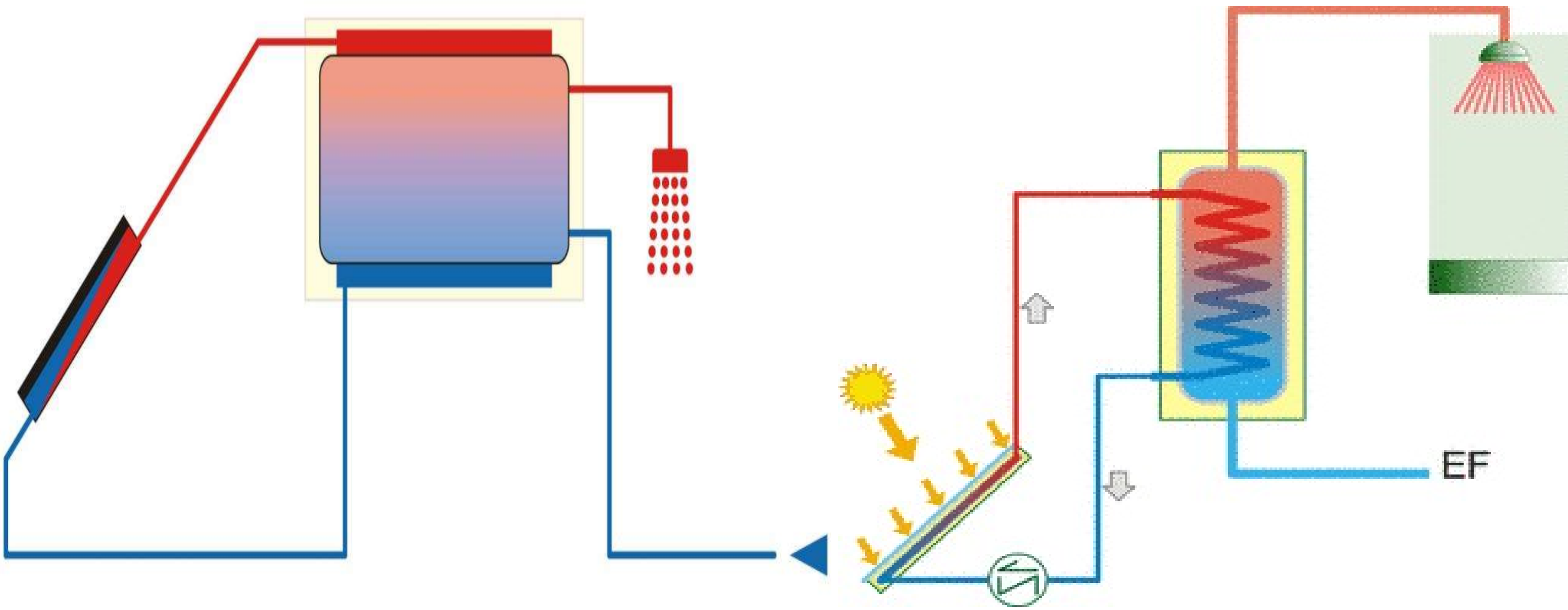
SWH TECHNOLGY
Thermosiphon Direct system(open loop system)





The same water is heated and used, but water quality should be useful

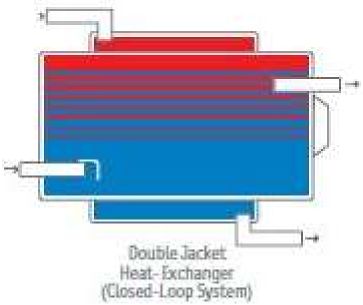
SWH TECHNOLGY
Thermosiphon Indirect system(close loop system)

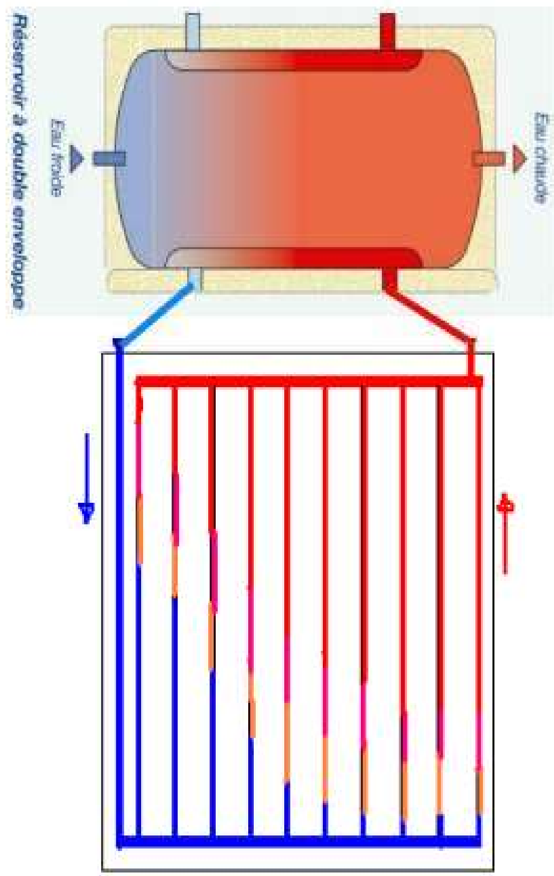


Primary water gives the heat to the secondary water, through a heat exchanger

Used when the water quality is bad and water is not useful

SWH TECHNOLGY
Thermosiphon Indirect technology



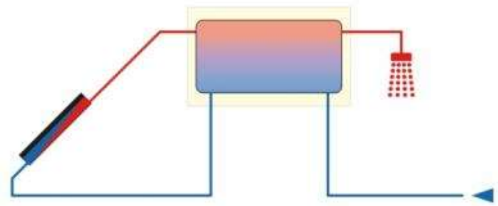


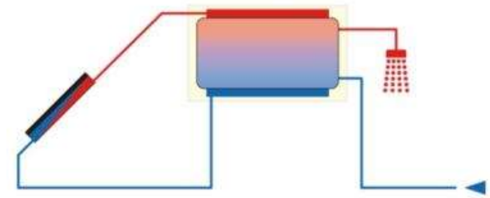
Double Jacket

Tubular exchanger

SWH TECHNOLGY
Thermosiphon system comparison

Open Loop system - **Close Loop system**





ADVANTAGES

Open Loop system:

- No need heat exchanger
- Simple
- Low temperature losses
- No need expansion tank

Close Loop system:

- Reduction of the limestone in tube
- Hygienic
- No corrosion

DISADVANTAGE

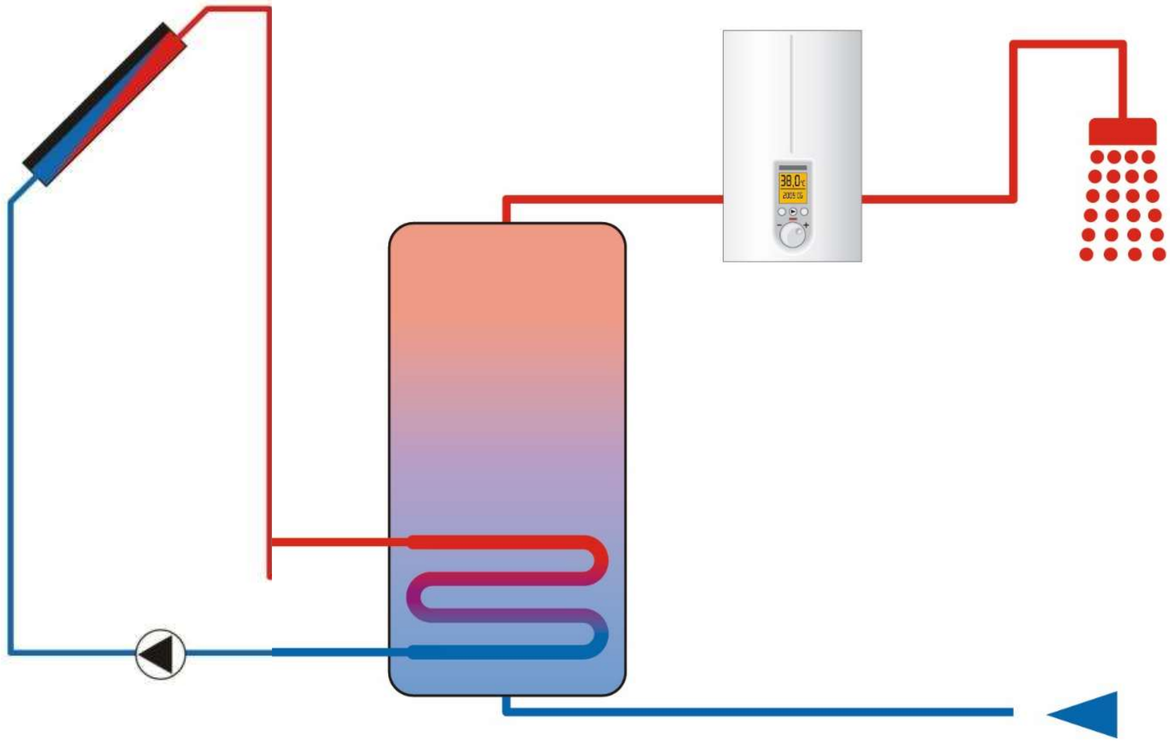
Open Loop system:

- Corrosion
- Limestone in collector
- Hygienic problem in water

Close Loop system:

- Need a heat exchanger
- Need an antifreeze
- More expensive
- High temperature losses

SWH TECHNOLGY
Forced circulation system

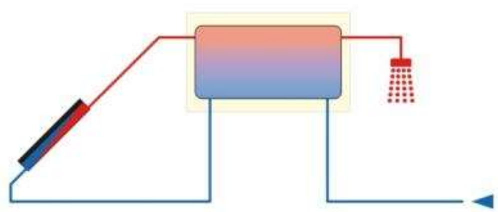


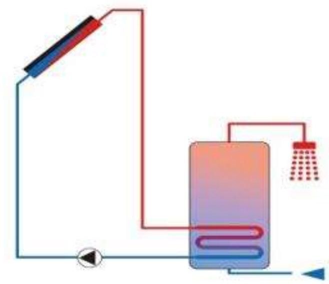
- The primary water is heated and gives its energy to the secondary water
- The tank is separated to the collector
- the pump Allows the circulation of the heat transfer fluid between the collector and the tank

SWH TECHNOLGY

Comparison between Thermosiphon and Forced circulation

Thermosiphon - **Forced circulation**





ADVANTAGES

Thermosiphon:

- No water pump
- No regulation system
- No electricity supply
- Simple and independent

Forced circulation:

- Independent location
- Ability to separate tank- collector
- Large scale system possible
- Storage tank protected inside

DISADVANTAGE

Thermosiphon:

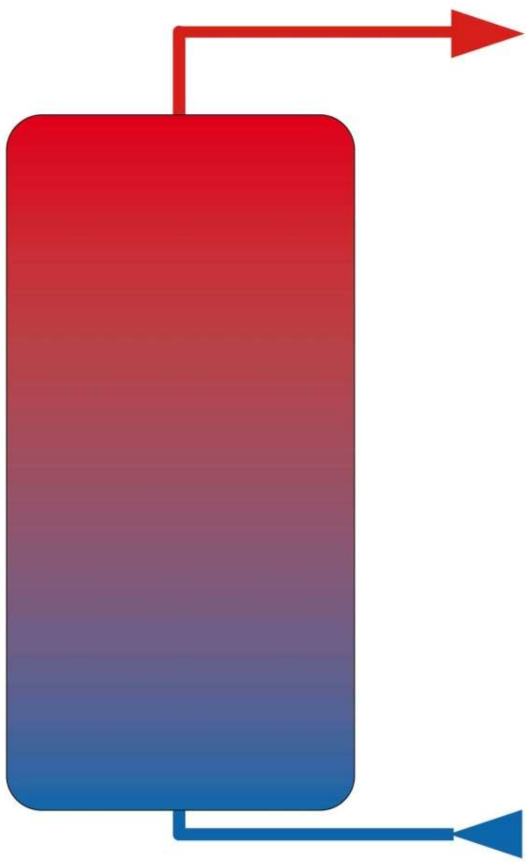
- Storage above the collector
- Storage outside
- For small capacities
- Bad system optimization

Forced circulation:

- Need a pump
- Need a regulation system
- Need a supply electricity
- System interrupted during an electricity shut off

SWH TECHNOLGY
SWH Tank : Technologies & Capacities

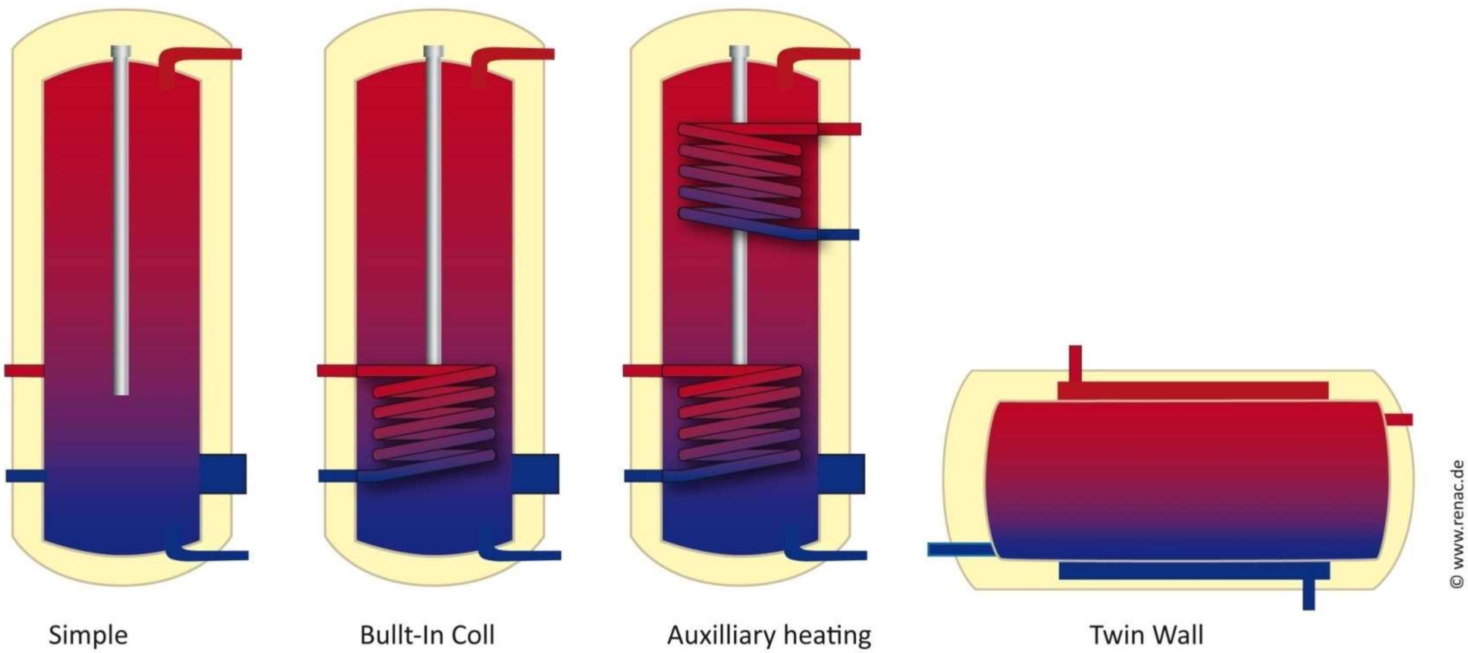
Ideal storage conditions



- Small storage volume (high specific heating capacity)
- Low heat loss (low volume/area ratio, good insulation)
- Good thermal stratification (means having a vertical tank)
- Design for a 25 year lifespan
- Ability to support the required temperatures and pressures
- Environmentally friendly tank material and heat transfer fluid..

SWH TECHNOLGY
SWH Tank : Technologies & Capacities

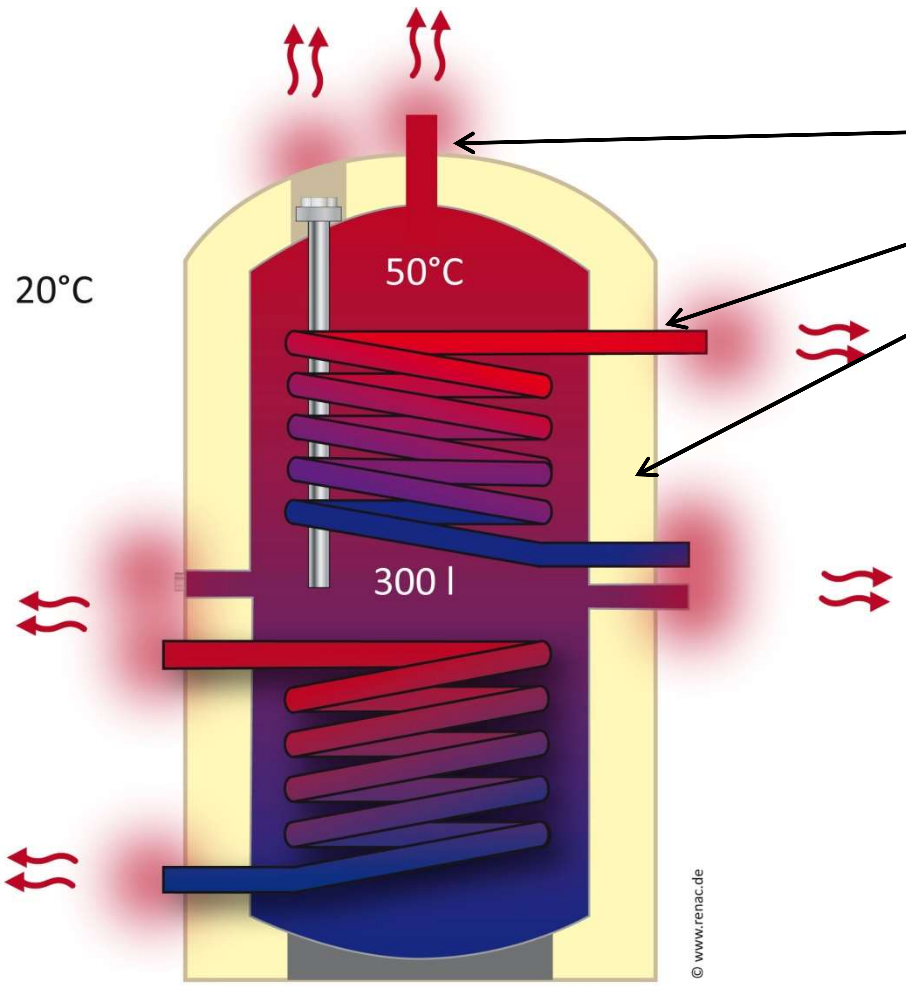
Tank design



- Capacity : 80 L – 3000 L
- Orientation : vertical or horizontal
- With or without heat exchanger?
- Material : Mild steel ; stainless steel; enameled steel
- With or without air vent

SWH TECHNOLGY
SWH Tank : Technologies & Capacities

The importance of a good insulation



Example:

0.6W/K (x2) 36W
0.3W/K (x2) 54W
1.4W/K (x2) 42W

Total:132 W

As per 24 hours per day and during 365 days

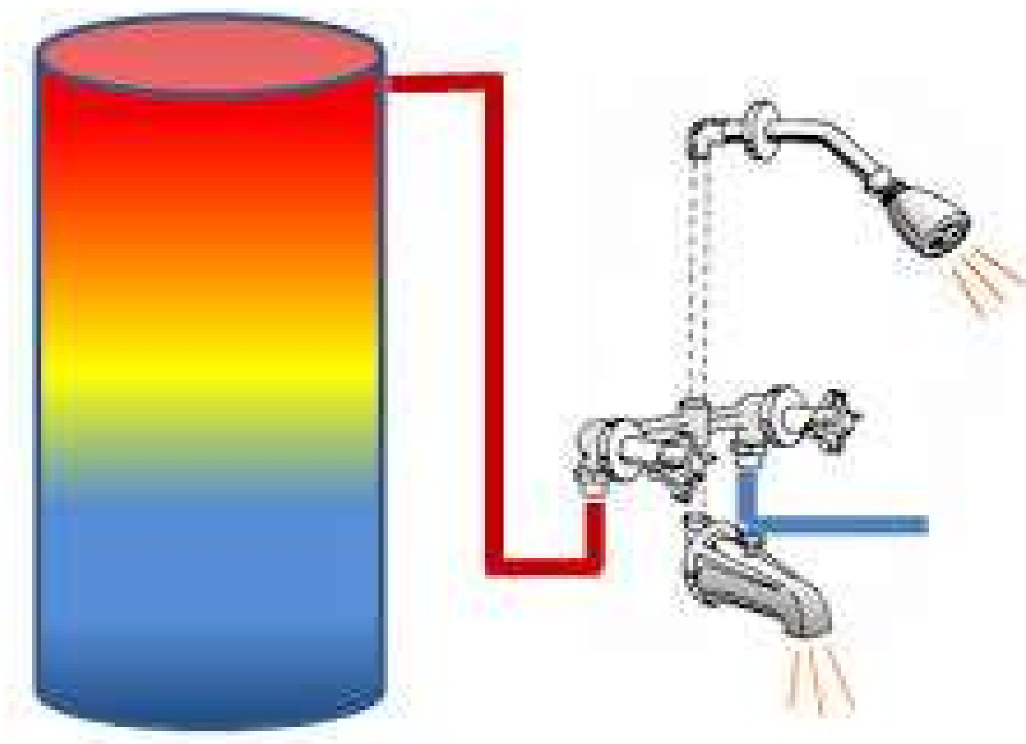
Annual losses: 1156 kWh

Annual difference in heat losses between a 300l storage well and badly isolated ≈ 365kWh/an

≈ equivalent to the annual energy gain of a 1-1.2m² collector

SWH TECHNOLGY
SWH Tank : Technologies & Capacities

Thermal stratification in a Tank



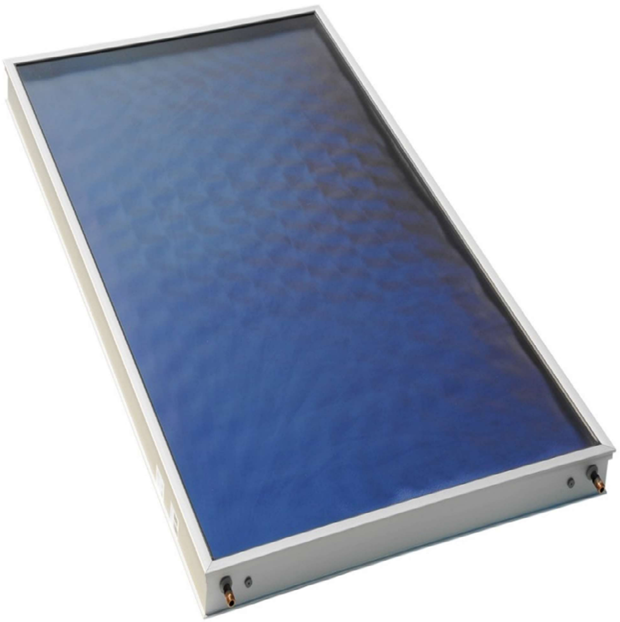
Hot water is located at top tank / Cold water at bottom tank

SWH TECHNOLGY
SWH Tank : Technologies & Capacities

Main parameters for selecting a tank

- System temperature?
- Water contains minerals and chlorine?
- Internal or external heat exchanger?
- Auxiliary heating?
- For which application? Small or large scale?
- Availability?
- Cost? Guarantee,

SWH TECHNOLGY
Collector : Technologies



Flate plate collector

Unglazed solar collector

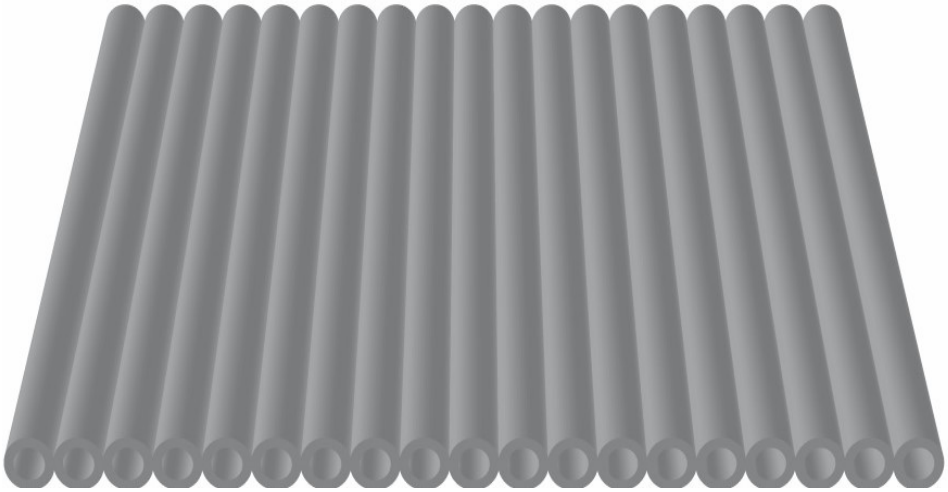
SWH TECHNOLGY
Collector : Technologies

Evacuated tube

Concentrated solar collector

SWH TECHNOLGY
Collector : Technologies

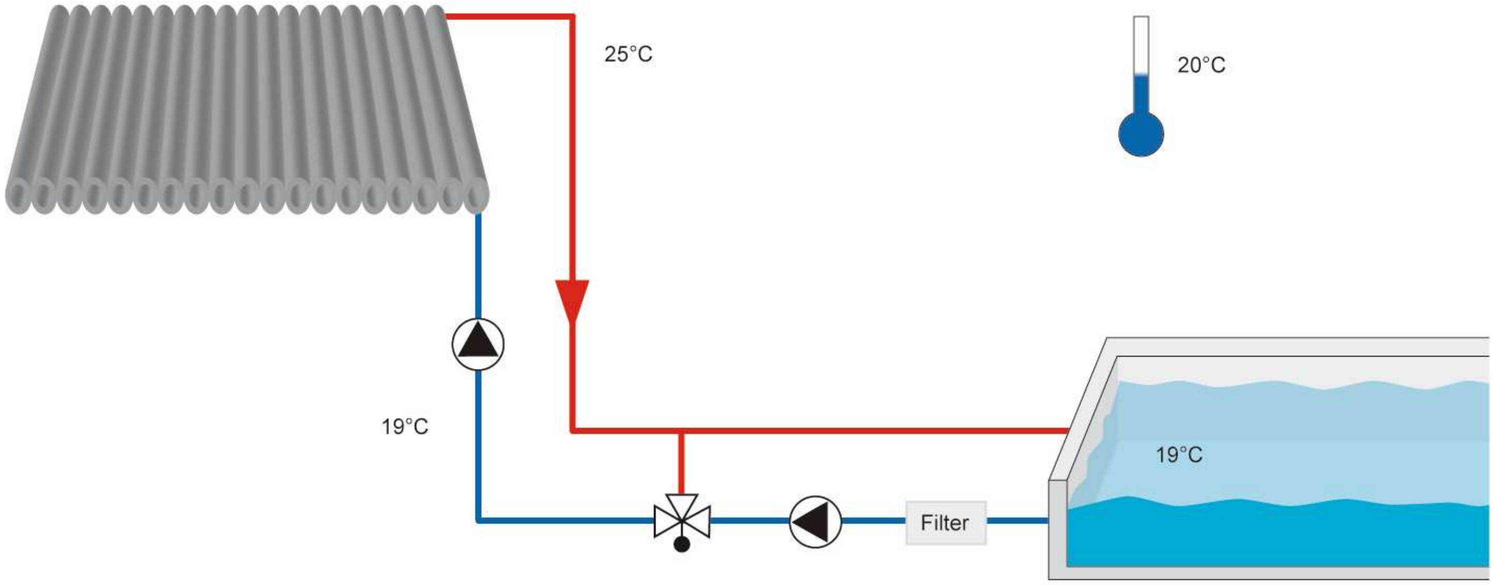
Unglazed solar collector



- No cover
- No insulation
- Application at low temperatures
- Pool heating
- Highly effective
- Material: rubber (EPDM) plastics (PP, PE)
- Simple
- Cheap
- Long life expectancy

SWH TECHNOLGY
Collector : Technologies

Solar Carpet application

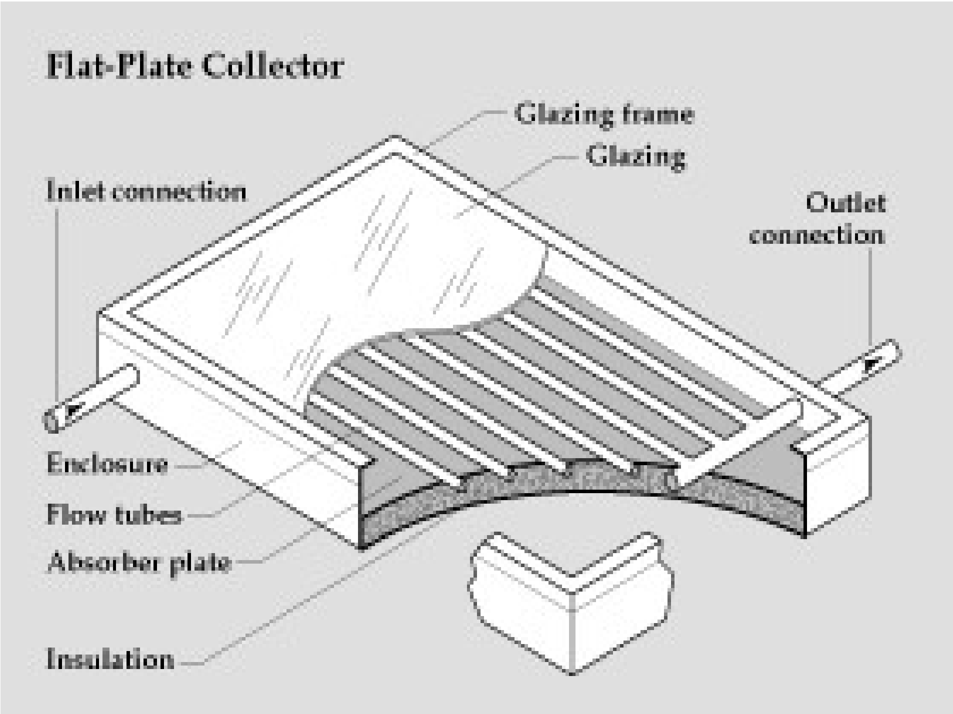


SWH TECHNOLGY

Collector : Technologies

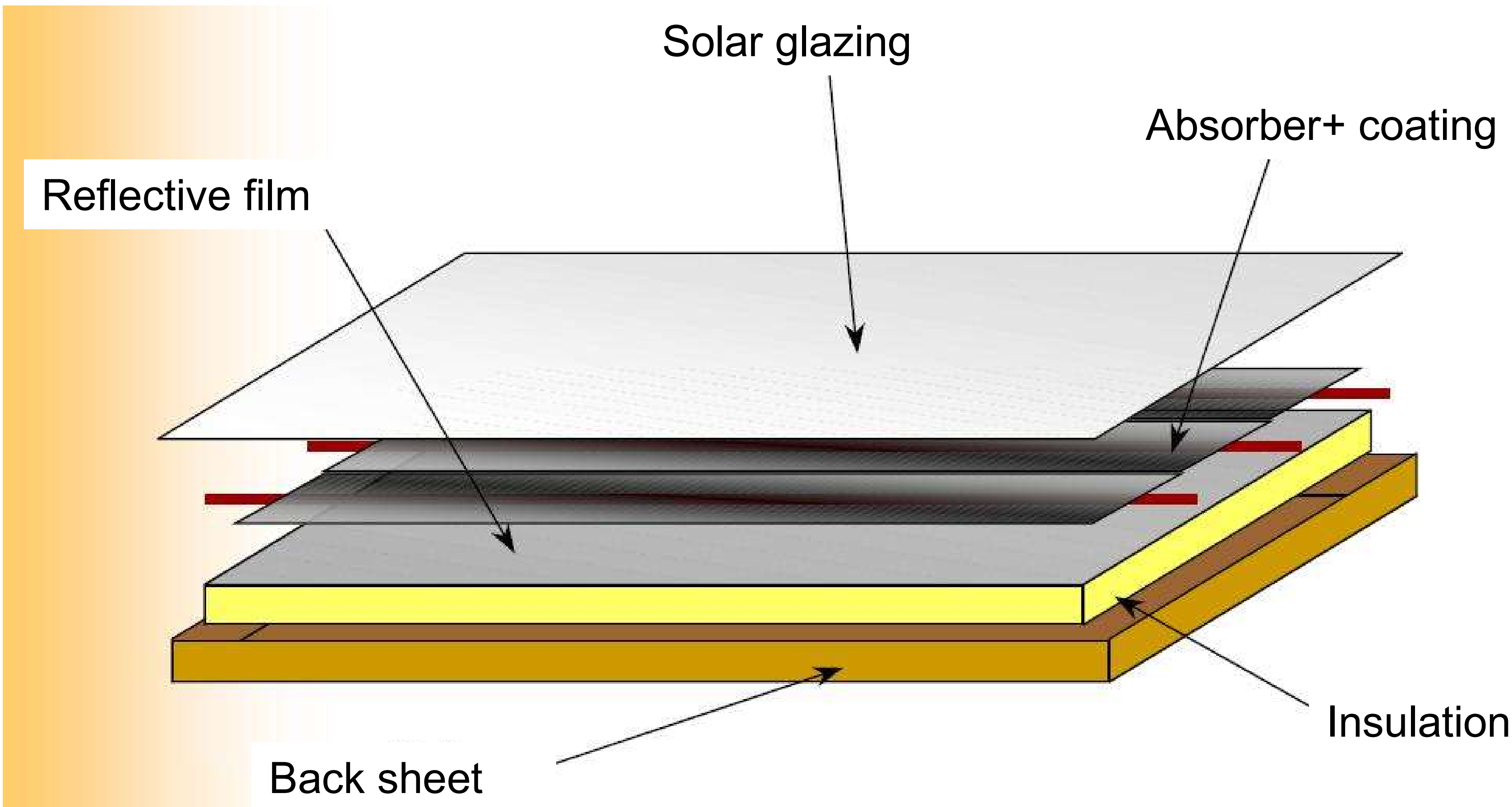
Flat plate collector

Flat-plate collectors are the most widely used kind of collectors in the world for domestic water-heating systems and solar space heating/cooling. The first accurate model of flat plate solar collectors was developed by Hottel and Whillier in the 1950's.



SWH TECHNOLGY
Collector : Technologies

Flat plate collector components



SWH TECHNOLGY
Collector : Technologies

Flat plate collector components

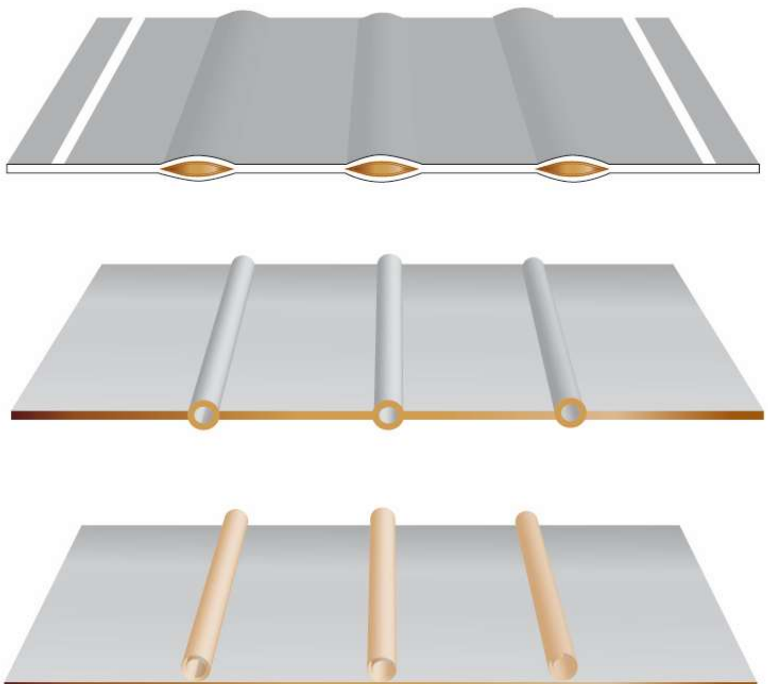
The absorber: is usually a sheet of high-thermal- conductivity metal such as copper or aluminum, with tubes either integral or attached. Its surface is coated to maximize radiant energy absorption and to minimize radiant emission.

The insulation : reduces heat loss from the back or the sides of the collector.

The cover sheets, called glazing: allow sunlight to pass through the absorber but also insulate the space above the absorber to prevent cool air to flow into this space.

SWH TECHNOLGY
Collector : Technologies

Absorber types



- Copper absorber
- Aluminum absorber with copper plate
- Copper pipe between two copper plates
- Copper pipe welded to a sheet of copper or aluminum

SWH TECHNOLGY
Collector : Technologies

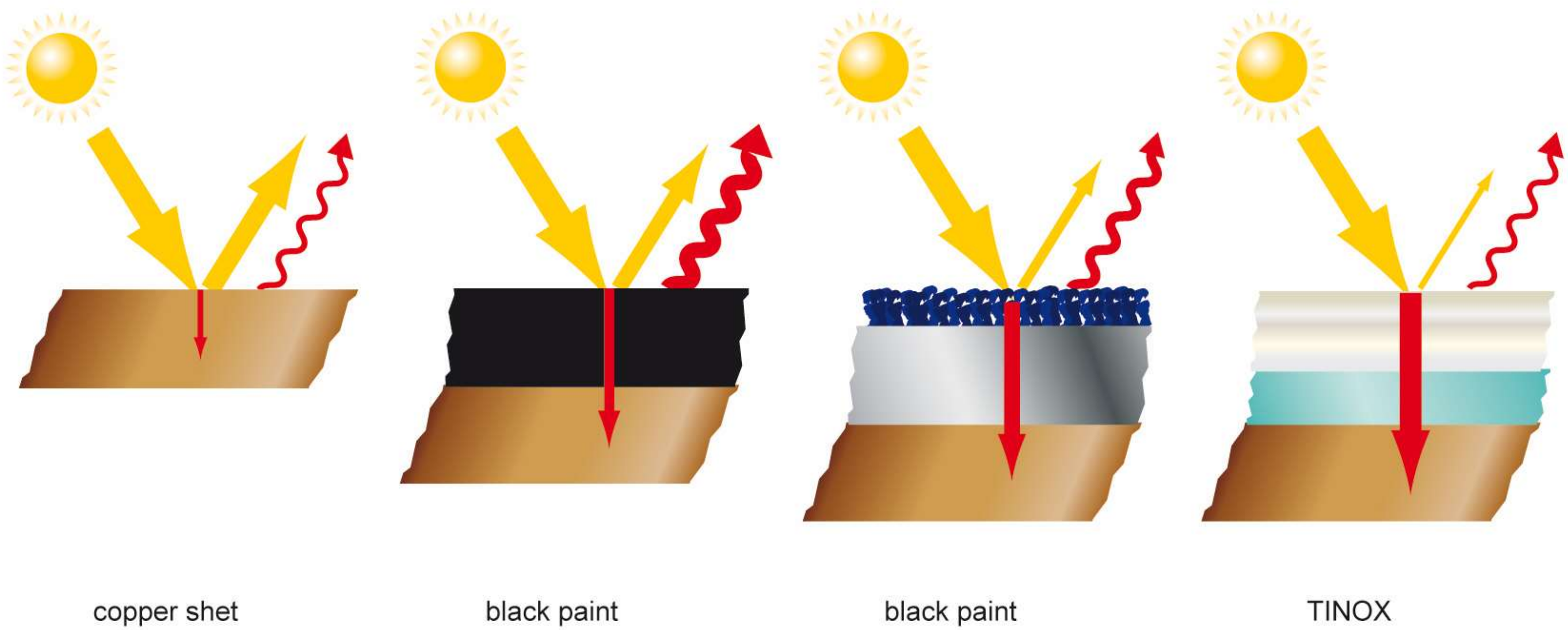
Main characteristics of absorber coating

- ❑ High absorption + low emissions coefficient
- ❑ Non-corrosive, stable in the long term
- ❑ Simple coating process
- ❑ Optimization of use and material costs

Type:	Absorption	Emission
• Black paint	app. 90%	app. 20%
• Black chrome	95% - 96%	5% - 16%
• Tinox	92% - 95%	2% - 4%

SWH TECHNOLGY
Collector : Technologies

Absorption and emission coefficient of materials



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• Black paint	app. 90%	app. 20%
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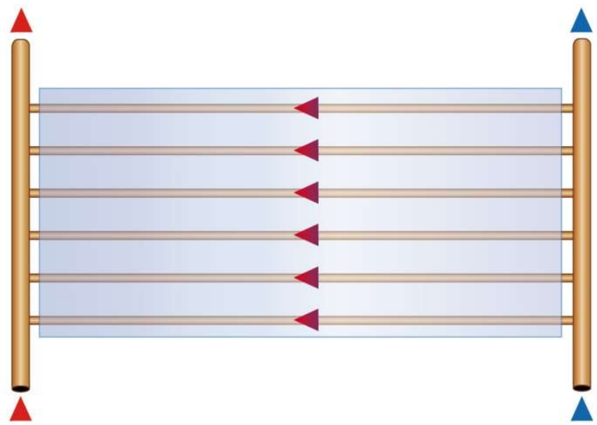
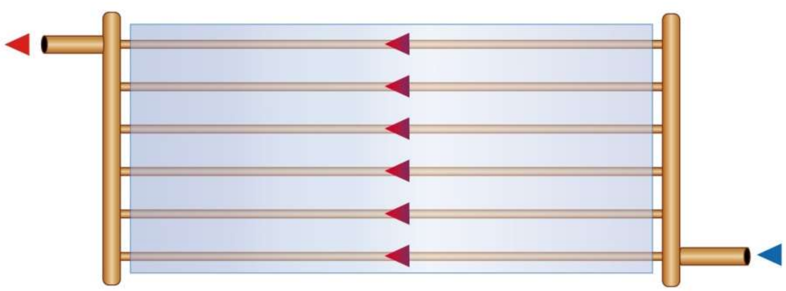
• Tinox	92% - 95%	2% - 4%

SWH TECHNOLGY
Collector : Technologies

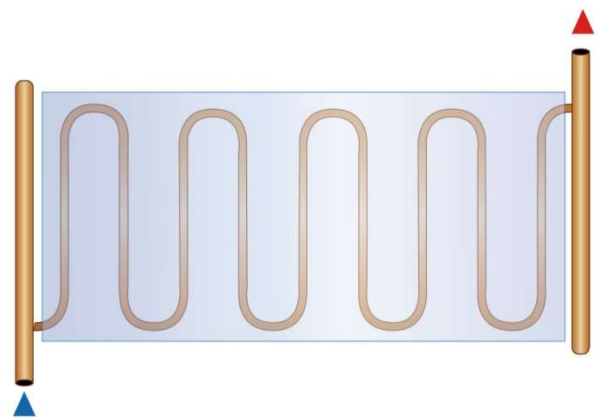
Absorber grid form



Scale form



Low pressure loss



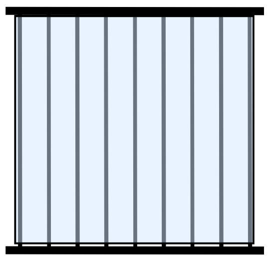
Serpentine form

High pressure loss

SWH TECHNOLGY
Collector : Technologies

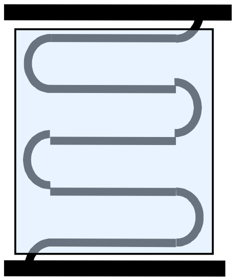
Absorber grid form

Scale form:



- Few pressure loss
- Allows serial connections
- Low flow systems
- “Thermosiphon” system

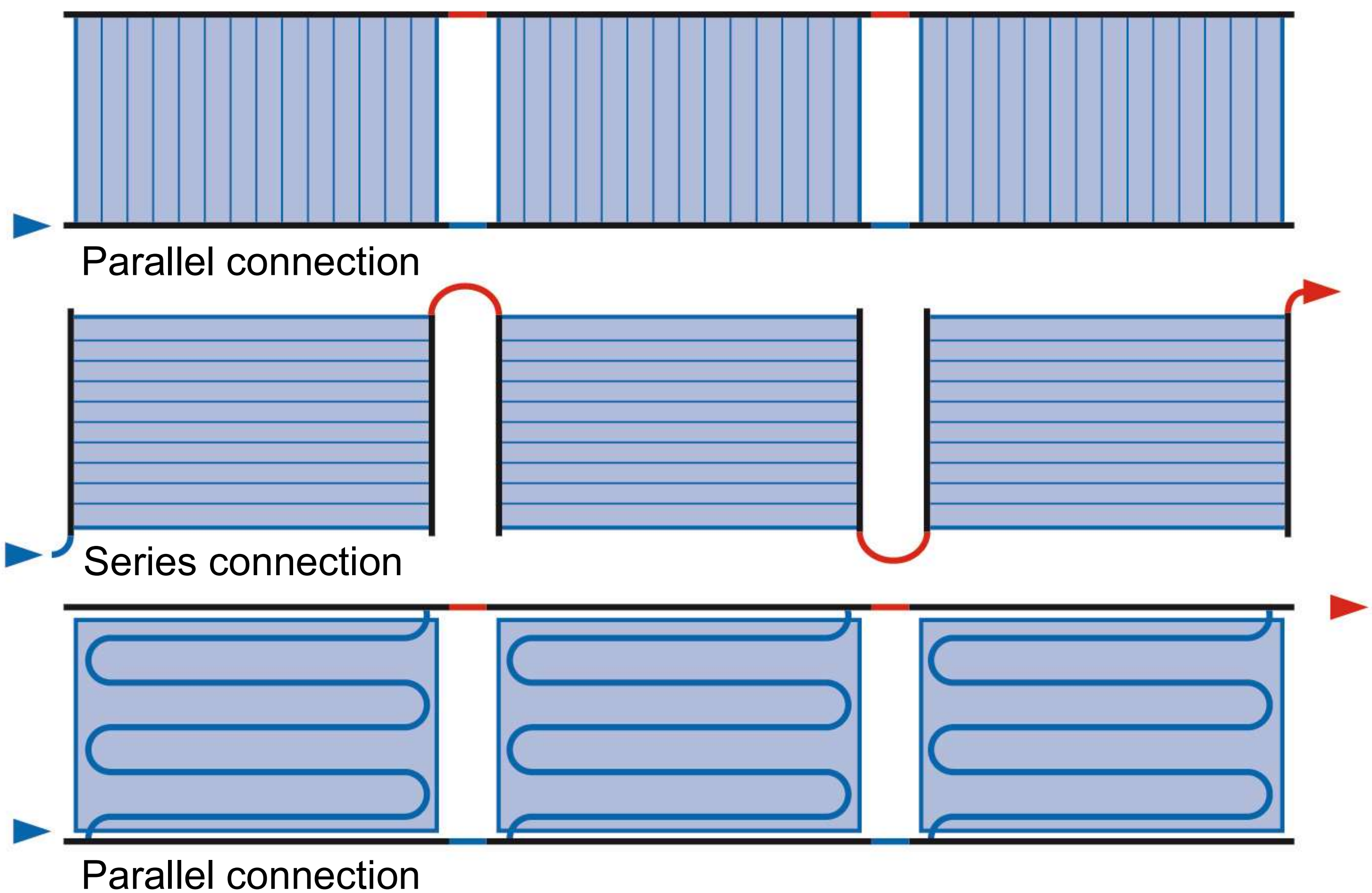
Serpentin form



- Significant pressure losses
- Allows parallel connections
- High flux system
- Forced circulation system

SWH TECHNOLGY
Collector : Technologies

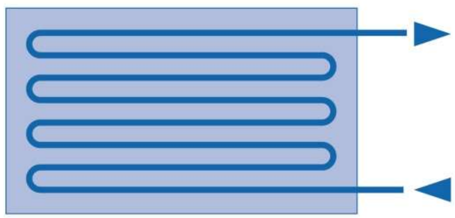
Absorber type connection

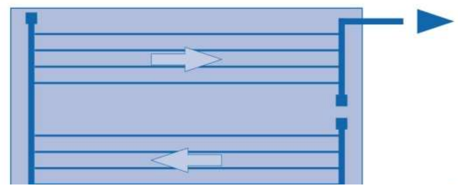


SWH TECHNOLGY
Collector : Technologies

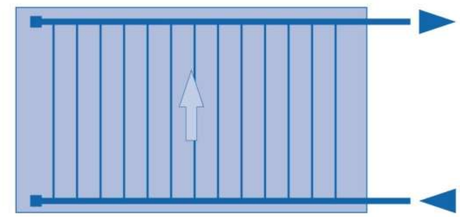
Stagnation behavior

- Steam easily leaves the collector, ensuring low pressure

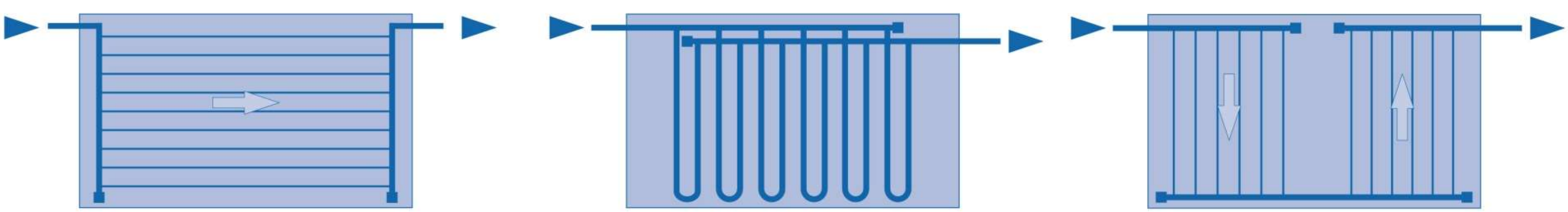




Opération normale du capteur

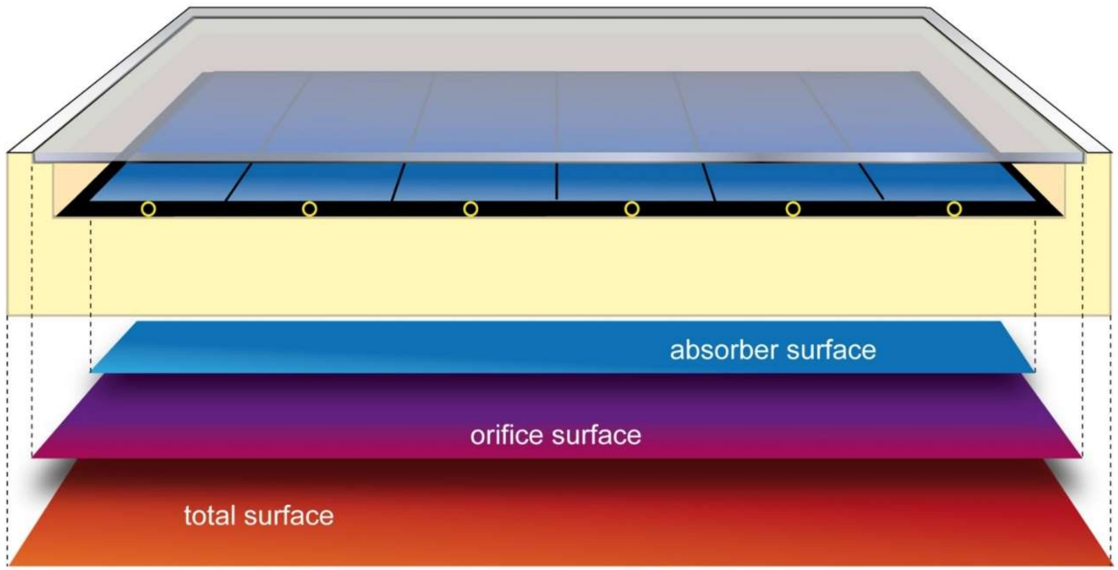


- Steam leaves the collector with difficulty, which has the effect of trapping liquid under high pressure



SWH TECHNOLGY
Collector : Technologies

Different surfaces dimension

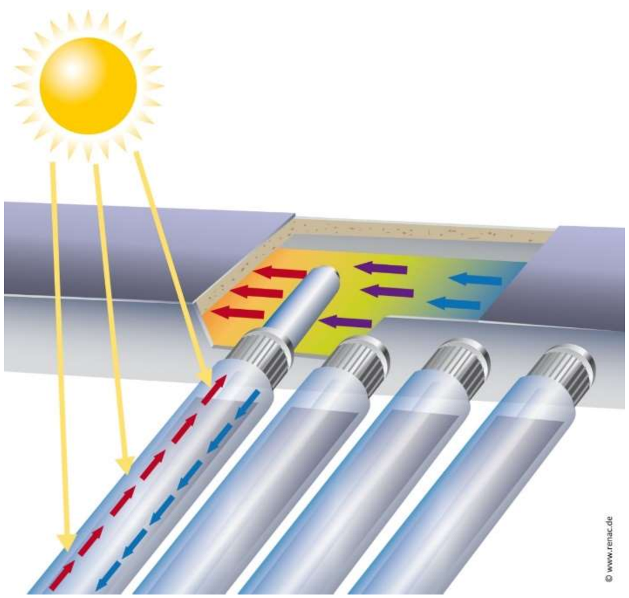


Total surface = orifice surface (aperture) + absorber surface

SWH TECHNOLGY
Collector : Technologies

Evacuated Tube

Evacuated (or Vacuum) Tubes are solar panel built to reduce convective and heat conduction loss (vacuum is a heat insulator).

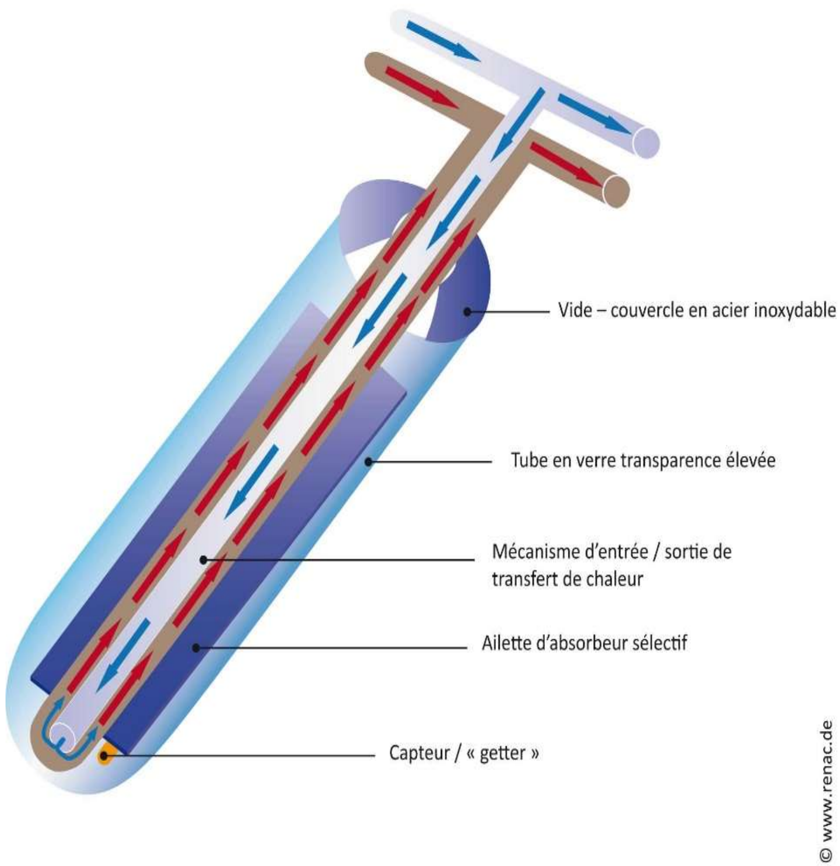


SWH TECHNOLGY
Collector : Technologies

Evacuated Tube

The sun's radiation is absorbed by the selective coating on the inner glass surface, but is prevented from re-radiating out by the silver-coated innermost lining which has been optimized for infrared radiation. This acts similarly as an one-way mirror.

This is very efficient. 93% of the sun light's energy hitting the tube's surface, is absorbed, whereas only 7% is lost through reflection and re-emission. The presence of the vacuum wall prevents any losses by conduction or convection - just like a thermos flask. Because of this, the system will work even in very low temperatures, unlike traditional flat plate

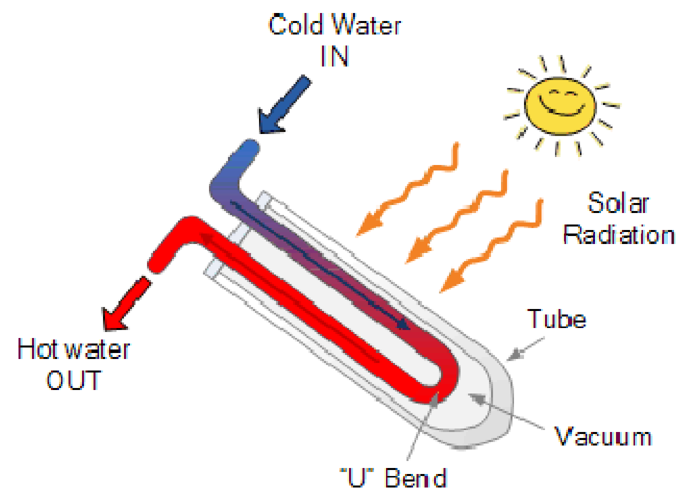


SWH TECHNOLGY

Collector : Technologies

Evacuated Tube types : Direct flow

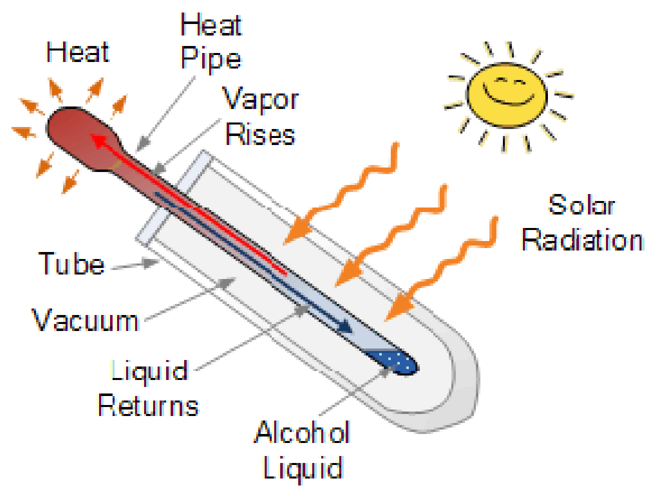
Direct flow evacuated tube collectors also known as “U” pipe collectors, are different from the previous ones in that they have two heat pipes running through the center of the tube. One pipe acts as the flow pipe while the other acts as the return pipe. Both pipes are connected together at the bottom of the tube with a “U-bend”, hence the name. The heat absorbing reflective plate acts like a dividing strip which separates the flow and the return pipes through the solar collector tubes. The absorber plate and the heat transfer tube are also vacuum sealed inside a glass tube providing exceptional insulation properties.



SWH TECHNOLGY
Collector : Technologies

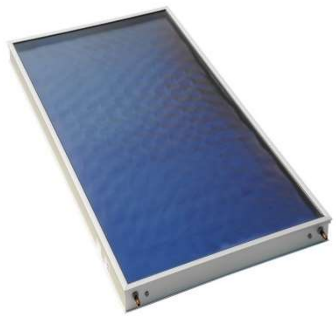
Evacuated Tube types : Heat pipe tube

In heat pipe evacuated tube collectors, a sealed heat pipe, usually made of copper to increase the collectors efficiency in cold temperatures, is attached to a heat absorbing reflector plate within the vacuum sealed tube. The hollow copper heat pipe within the tube is evacuated of air but contains a small quantity of a low pressure alcohol/water liquid plus some additional additives to prevent corrosion or oxidation.



SWH TECHNOLGY
Collector : Technologies

Differences between Flat plate and Evacuated collector

	Flat Plate Collector	Evacuated Tube collector
		
Cost	Less expensive	around 20% to 40% more expensive
Performance	Better in southern climate	Better in colder and/or cloudier conditions
Efficiency	Less efficient	20% more efficient than flat plate
Installation	More sensitive to sun radiation	Less sensitive to sun radiation and orientation
Heat losses	Convection and Convecting losses is high	Convection and Convicting losses is low
Temperature range	From 60 to 90 °C	From 60 to 120 °c

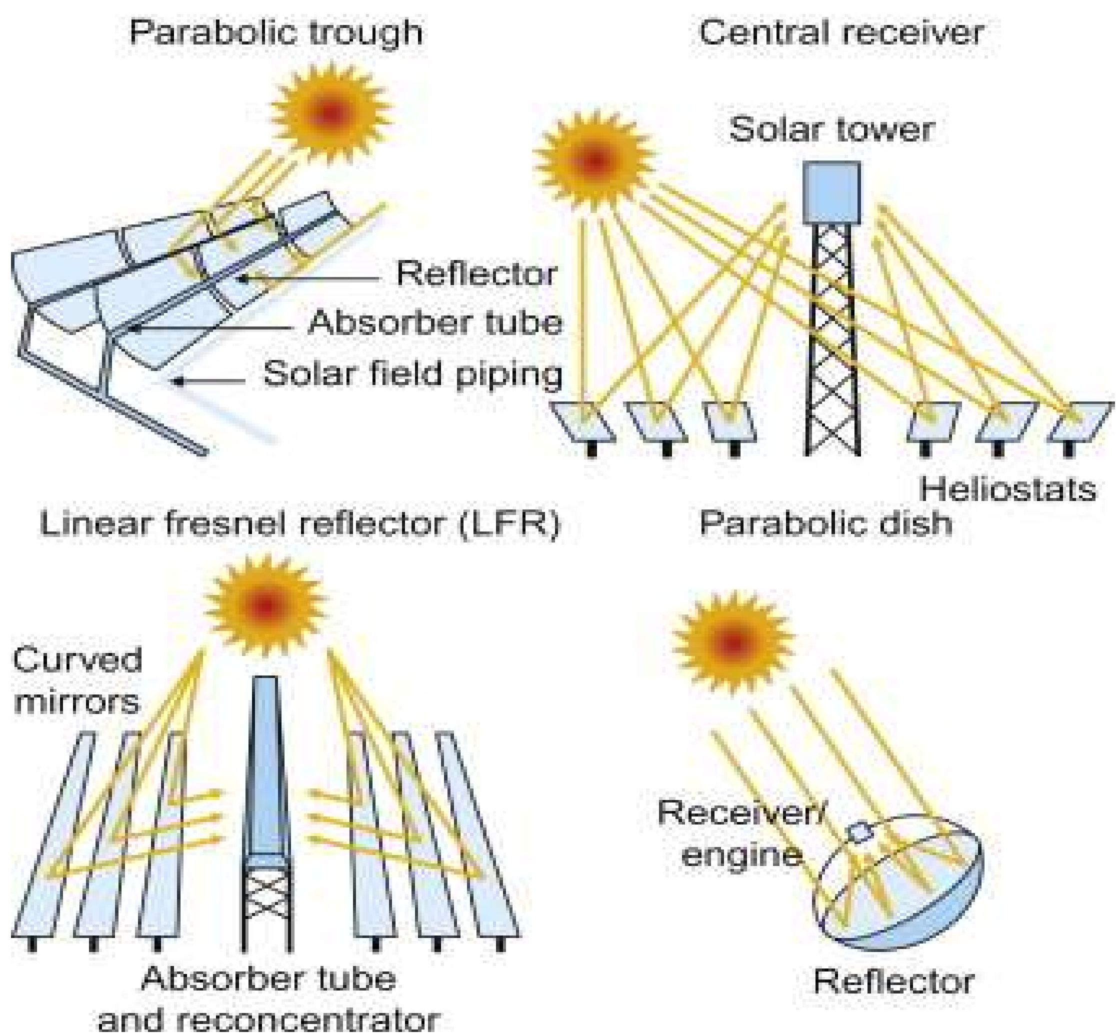
SWH TECHNOLGY
Collector : Technologies

Concentrated solar collector

- Concentrated Solar collector use radiation concentration when fluid temperature more than 100°C
- Radiation concentration can be static or dynamic
- This collector use stationary radiation concentration; It's usually used to heat liquid (water or water with anti freeze or diathermic fluid). It can be use for electricity generation and can be used in Solar cooling

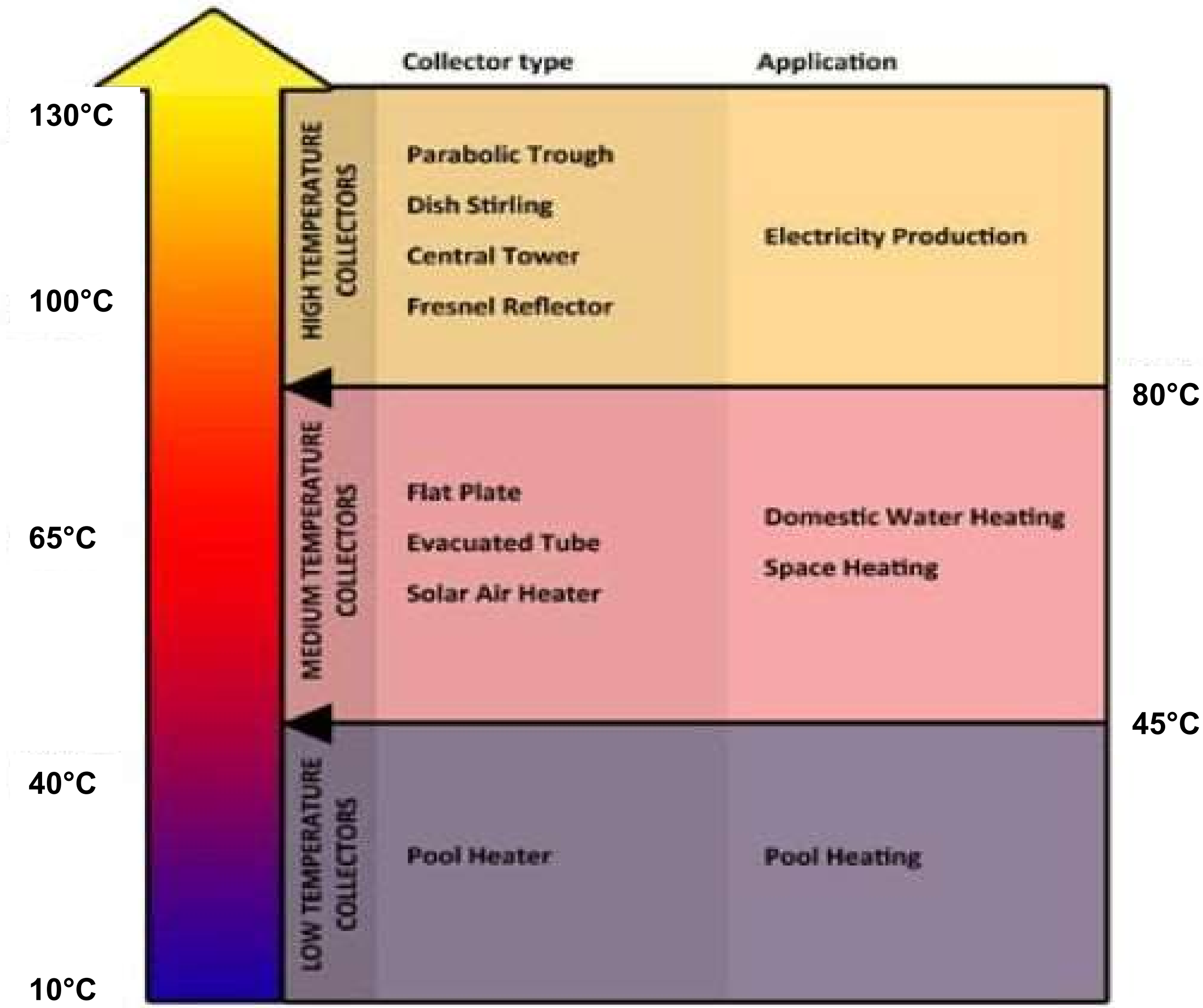
SWH TECHNOLGY
Collector : Technologies

Concentrated solar collector : different systems



SWH TECHNOLGY
Collector : Technologies

Classification collectors application



SWH TECHNOLGY
Collector : Efficiency

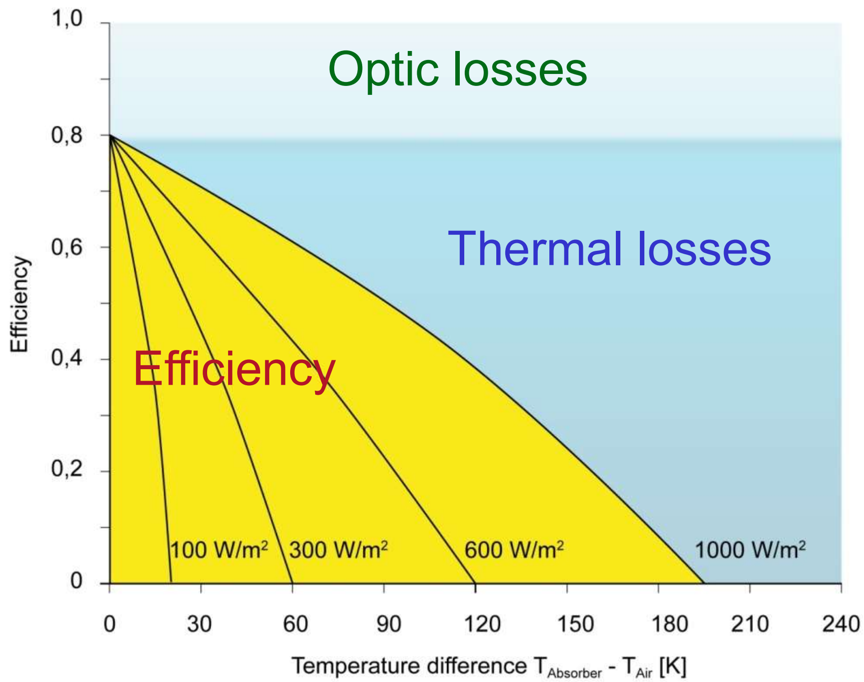
The collector efficiency depends on :

- Solar radiation
- Optic losses
- Thermal losses
- Temperature difference : T_c- T_a

Where :

Tc : Collector average temperature

Ta: Ambiant temperature



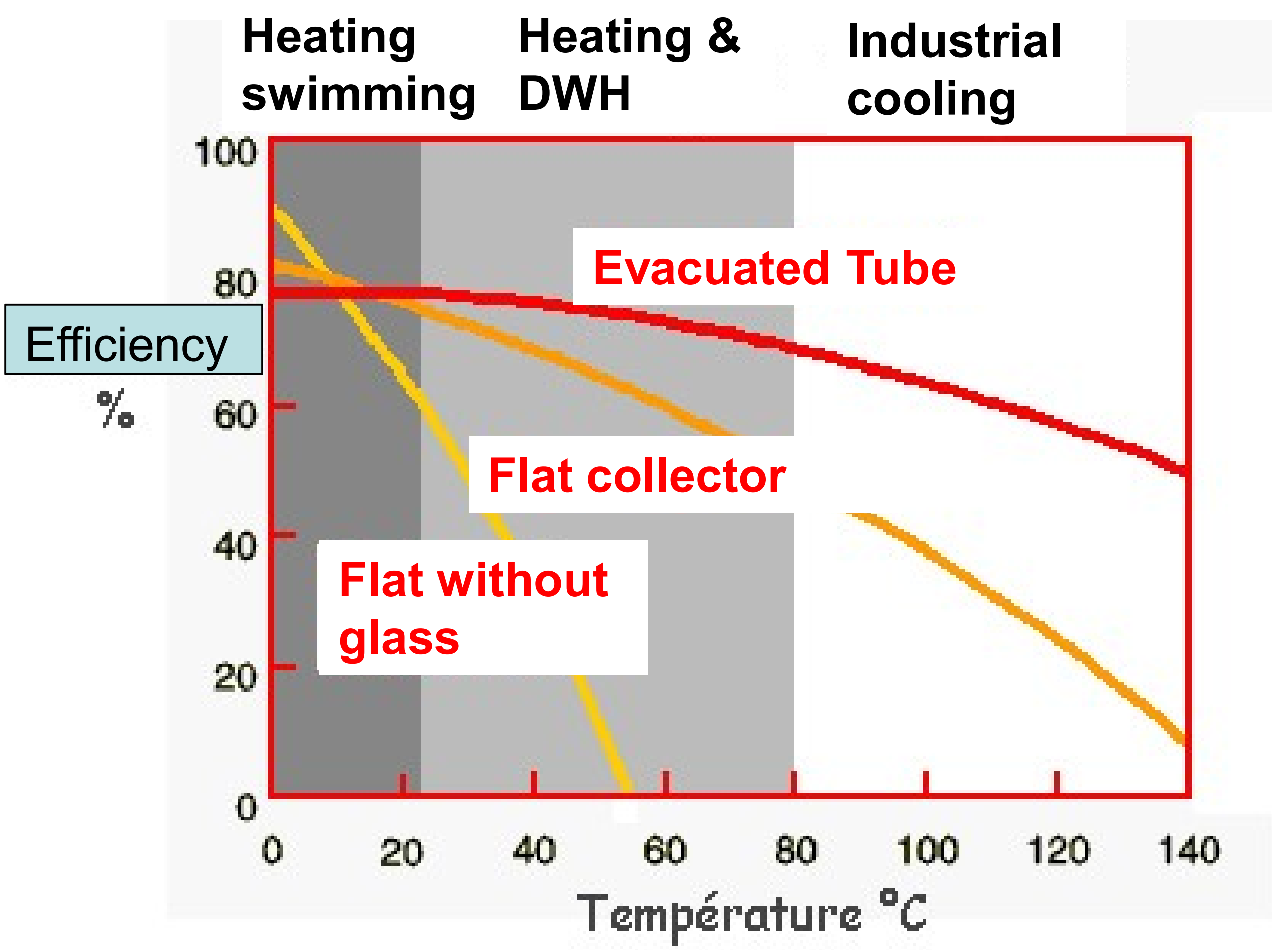
SWH TECHNOLGY
Collector : Efficiency

$$\eta = \eta_0 - a_1 \frac{(\vartheta_m - \vartheta_a)}{G} - a_2 \frac{(\vartheta_m - \vartheta_a)^2}{G}$$

- η_0 = efficiency zero losses (optic losses) [K]
- a_1 = Linear coefficient of heat transfer [W/m²K]
- a_2 = Quadratic coefficient of heat transfer [W/m²K²]
- ϑ_m = Collector average temperature [K]
- ϑ_a = ambient temperature [K]
- G = irradiation [W/m²]

SWH TECHNOLGY
Collector : Efficiency

Application field



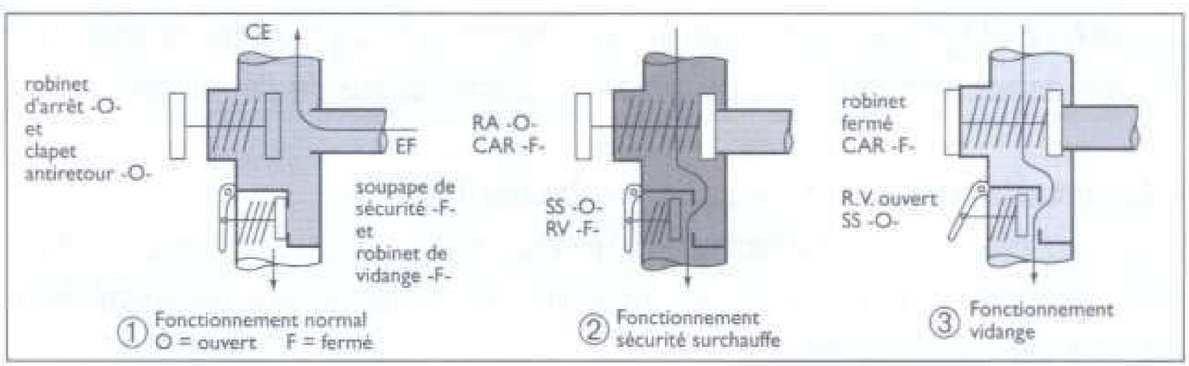
SWH TECHNOLGY
Accessories

Safety group

Role : Protect the individual SWH against overpressure

Function :

- Safety valve: evacuation of water in case of overheating,
- Check valve
- Manual water heater drain valve
- Shutoff valve



SWH TECHNOLGY
Accessories
Magnesium Anode

Function : Barrier corrosion = To protect the tank against corrosion

SWH TECHNOLGY
Accessories

Electrical heater (Backup system)

Function : is an electrical resistor used as a heating supplement in case of insufficient sunshine or if the needs are higher than expected (backup system)

SWH TECHNOLGY
Accessories

Expansion Tank

Function :

- An expansion tank is another small tank that is attached to the water supply pipe of the SWH. The expansion tank is designed to handle the thermal expansion of water as it heats up in the SWH, preventing excessive water pressure (Overpressure).
- It is used in indirect and forced circulation system

SWH TECHNOLGY
Accessories

Coolant (antifreeze)

Function :

- It's a mixture of water and glycol
- To ameliorate the heat transfer
- To prevent fluid degradation by high temperatures
- To reduce the lime scale in the circuit
- 40 % glycol mixture provides frost protection down to -20 °C
- It is used only for indirect and forced circulation systems

Source: Resol

SWH TECHNOLGY
Accessories

Connecting pipework

Characteristics :

- To resist at high temperature and the corresponding pressures
- The common material used is copper
- The use of galvanized steel is to be avoided
- Plastic or multilayer tubes are prohibited for temperature higher than 70 °C
- Insulation is fundamental to conserving heat energy
- The insulation of the external pipes have to resist to UV light

Recommendation diameter sizes:

	Tank type & capacity	Cupper piping
Indicative proposed diameters	180 - 200 L	12/14
	300 L	14/16
	400 L	16/18
	500 L et plus	18/20 ou 20/22

SWH TECHNOLGY
Accessories

Insulation pipe

Material	Minimum Thickness e_{min}			
	[mm]		[“]	
D : diameter	d<22	d>22	d< 7/8	d> 7/8
Polyurethane	15	20	5/8	3/4
Mineral wool	20	30	3/4	1 1/4

Polyuréthane

Mineral wool

Insulation thickness = Pipe diameter

SWH TECHNOLGY
Accessories

Support structure

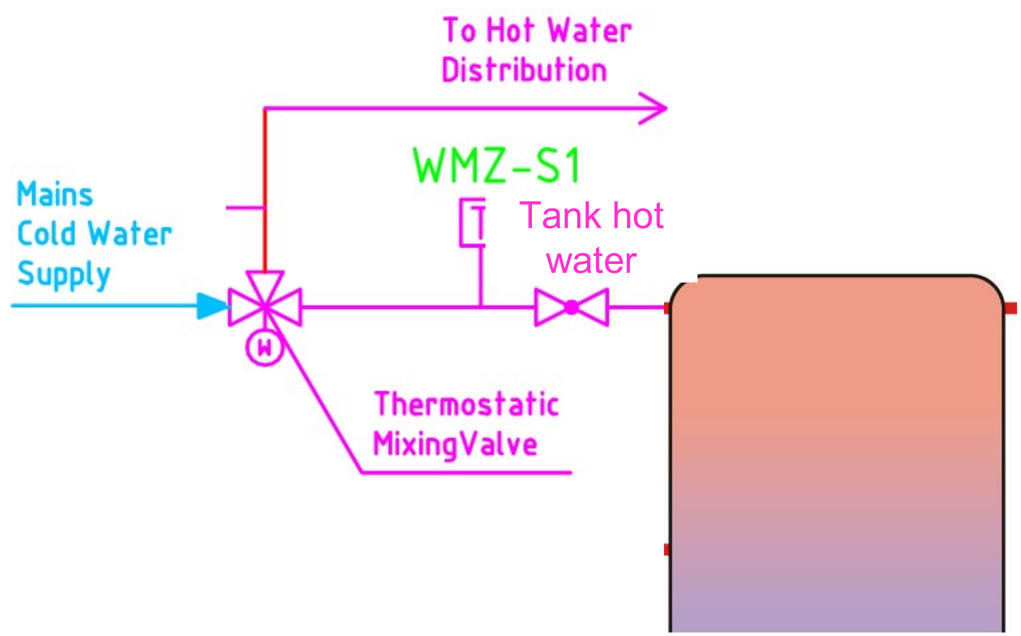
Requirements:

- Respond to the solidity needs necessary for
  weight and system stability
- Resist mainly climate efforts due to winds
- Resist corrosion (Galvanized iron or aluminum)
- The fixation accessories (nut, screw, washers… ..) have to be protected against corrosion (galvanized, stainless steel)

SWH TECHNOLGY
Accessories

Thermostatic Mixer (or Mixing valve)

- To prevent burns
- Located on the hot water outlet cylinder
- Cold water is mixed with hot water to obtain the programed temperature



SWH:
Technical drawings

Training of SWH installer & maintainer

Solar Water Heaters
Technical drawings

Objective:

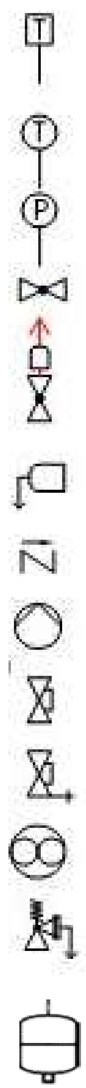
- ✓ Be informed on SWH components symbols
- ✓ Have knowledge on main system schemes
- ✓ Have detailed parameters on components association
- ✓ How to prepare site SWH drawing?

Duration

- ✓ 1:30 hour
- ✓ From : 13:30 to 15:00
- ✓ Close phones
- ✓ Don’t speak to each other

TECHNICAL DRAWINGS

Hydraulic symbol



Temperature sensor

Temperature gauge

Pressure gauge

Shut off valve

Purge valve

Degasser with valve

Control valve

Pump

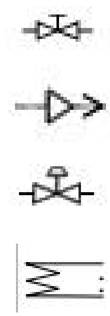
Tamper-proof valve

Flow gauge

Flow meter

Safety or pressure valve

Expansion tank



Isolating valve

One way valve

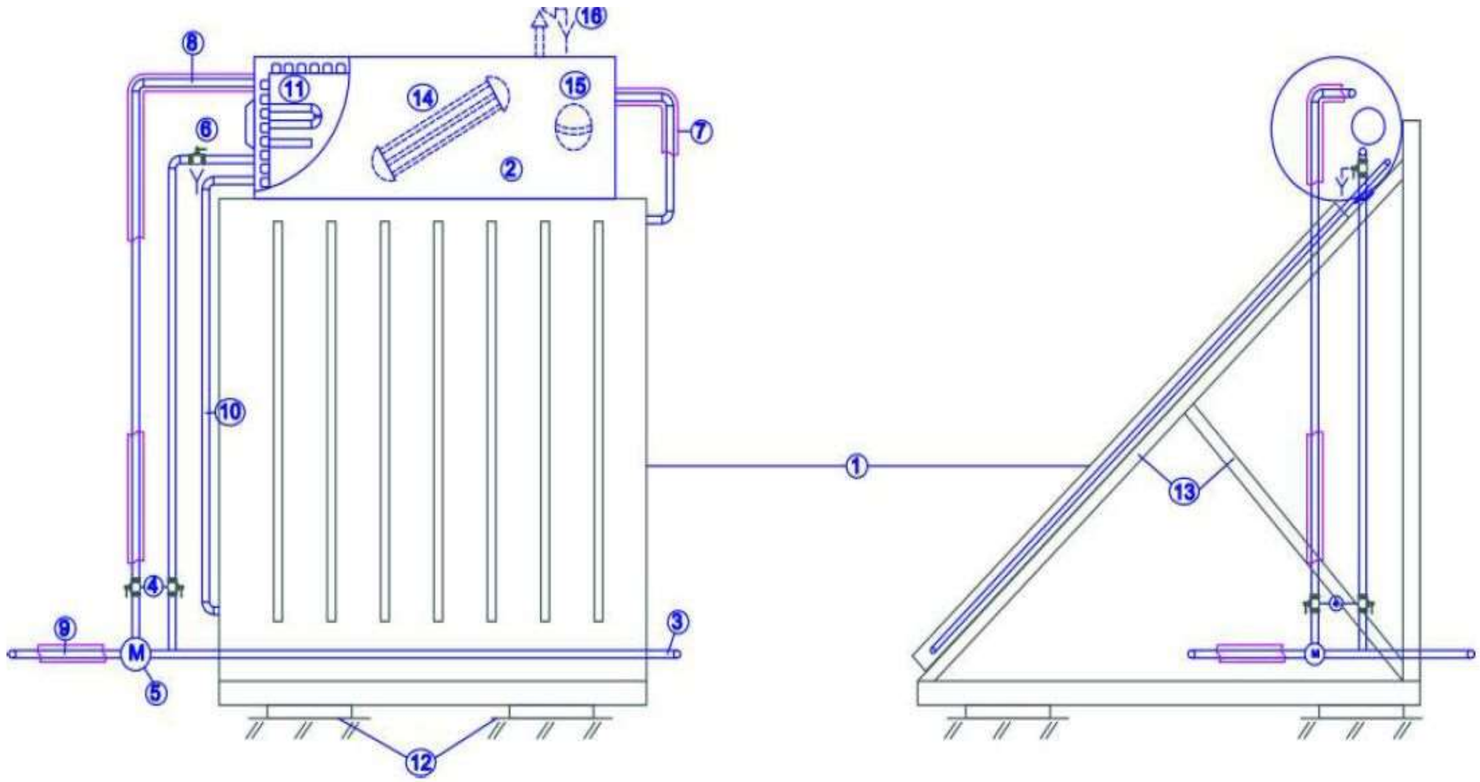
Thermostatic valve

Heat exchanger

TECHNICAL DRAWINGS

SWH scheme

YE1

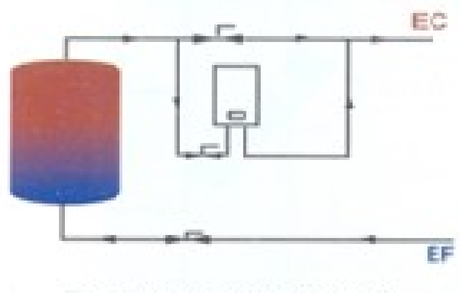


1) Solar Collector
2) Storage tank
3) Cold water inlet
4) Isolation valve
5) Thermostatic mixer
6) Safety group
7) Hot water collector outlet (insulated)
8) Solar hot water tank inlet (insulated)
9) Solar hot water mixed inlet (insulated)
10) Cold water collector inlet
11) Electric back up
12) Concrete slabs
13) Support structure
14) Heat exchanger(for Indirect and forced system)
15) Expansion tank (for Indirect and forced system)
16) Safety valve (for indirect and forced system)

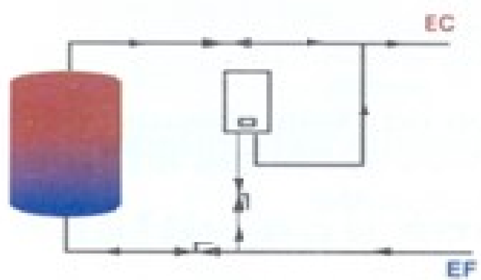
need high rsolution picture
Yahia El-Masry, 03-Aug-20

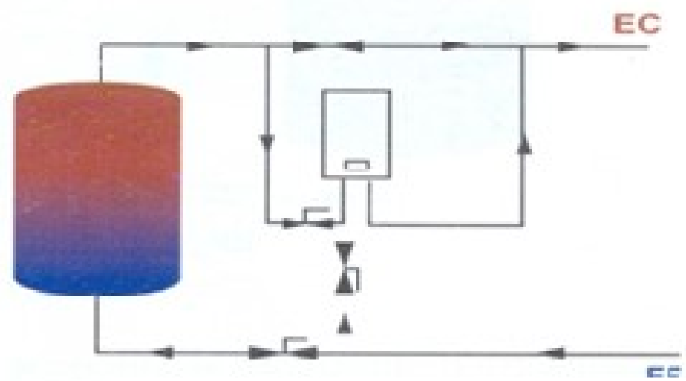
YE1

TECHNICAL DRAWINGS
Coupling backup at the SWH



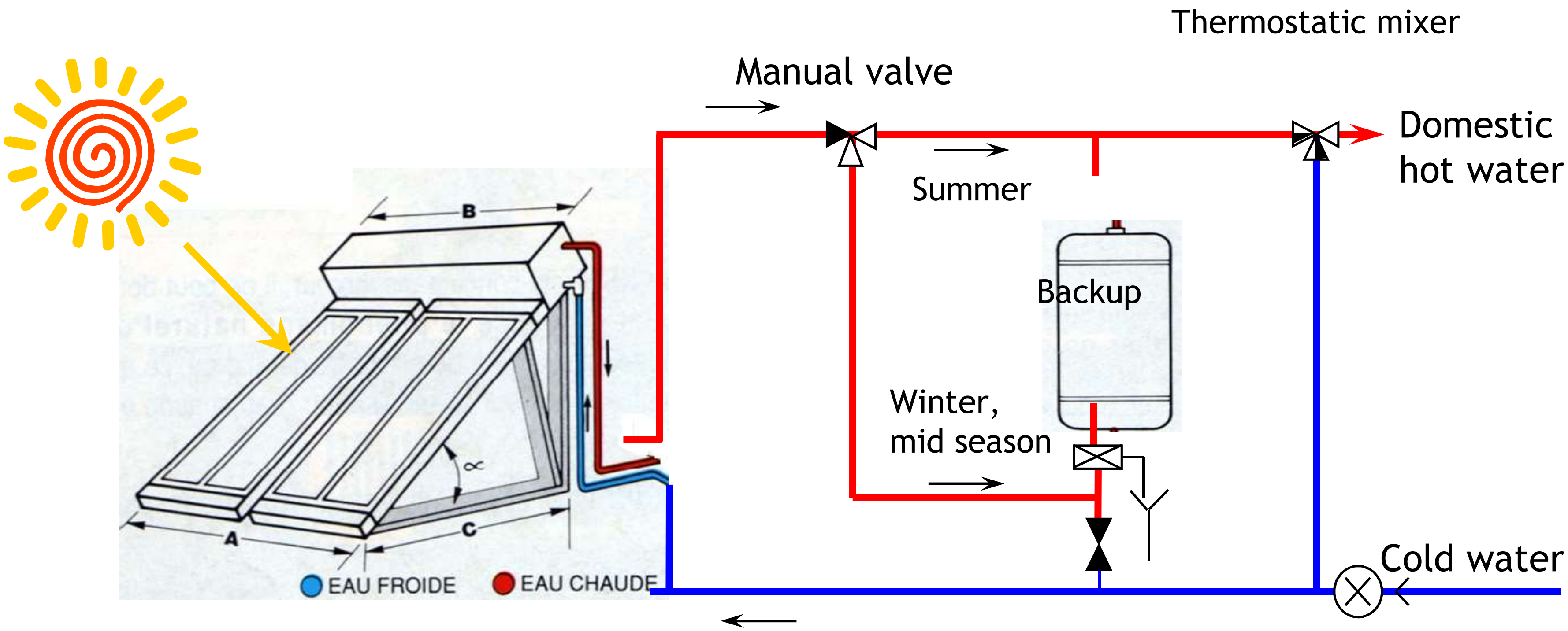
In serie with deviation





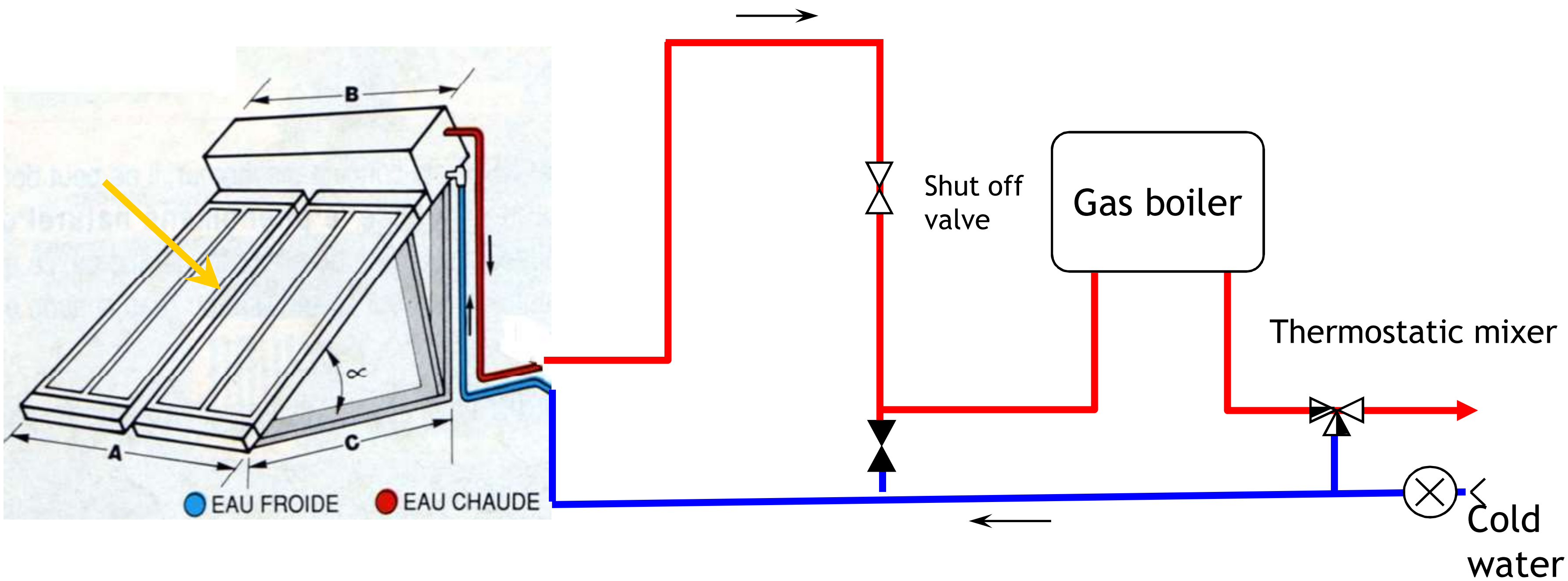
Mixed connection with deviation

TECHNICAL DRAWINGS
Coupling backup at the SWH



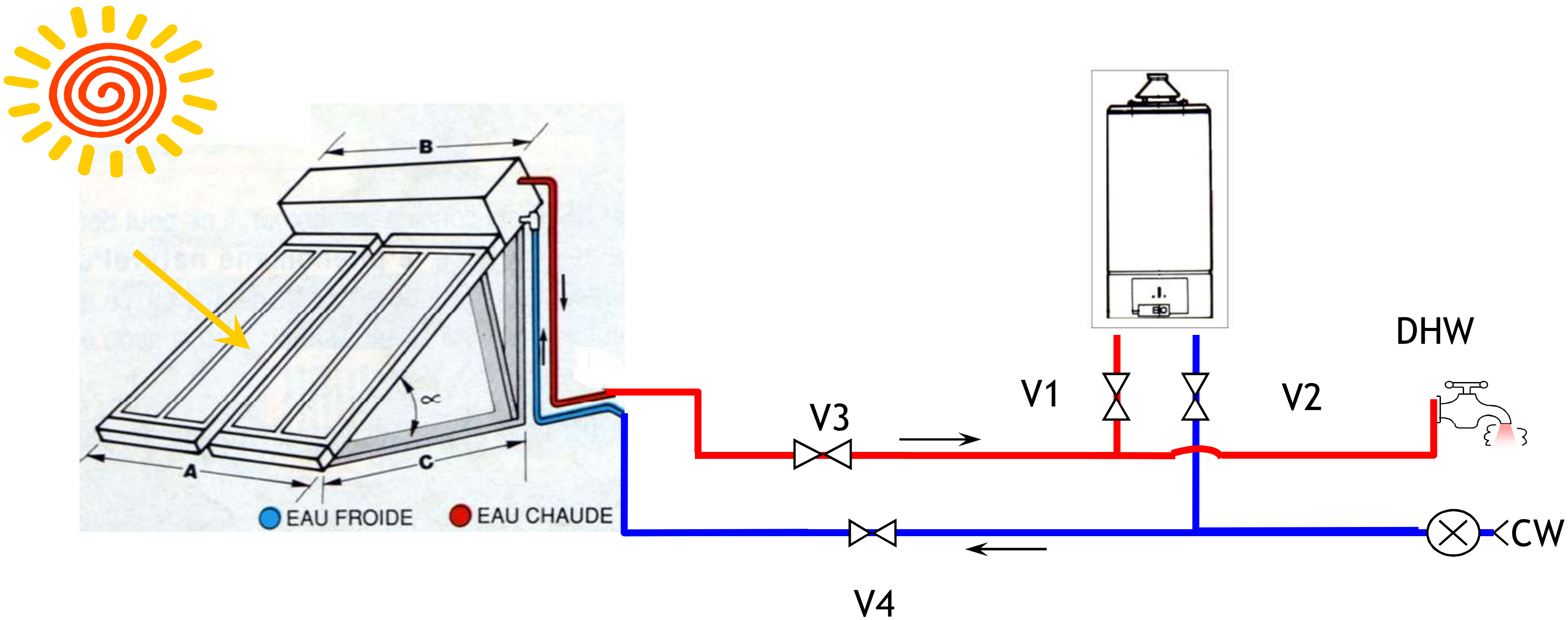
Two hydraulic circuits : one for summer needs and the other for winter and mid season needs

TECHNICAL DRAWINGS
Coupling backup at the SWH



Back up system : Gas boiler

TECHNICAL DRAWINGS
Coupling backup at the SWH

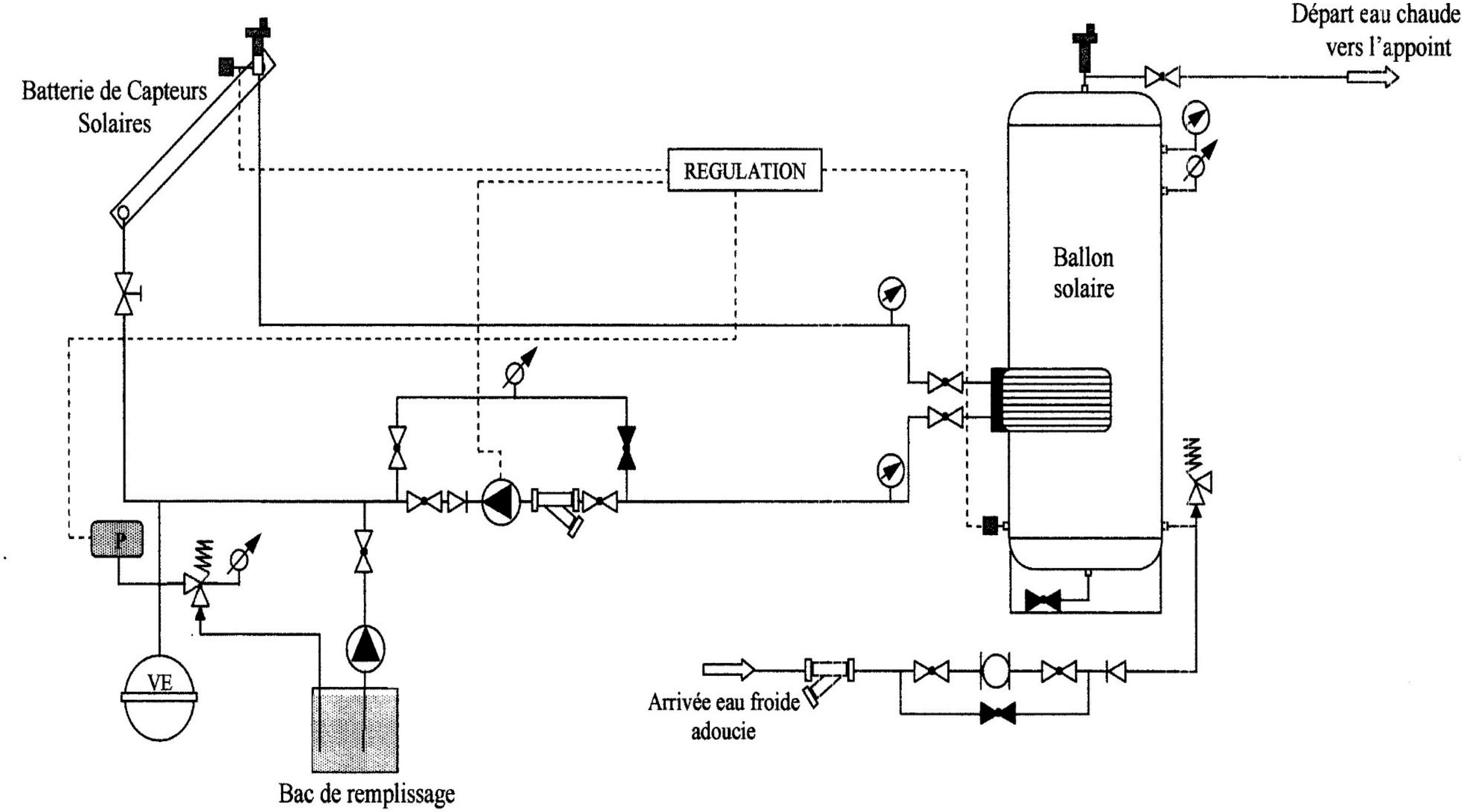


Operation	Closed	Open
Winter	V3, V4	V1, V2
Summer	V1, V2	V3, V4

DHW: Domestic hot water
CW : Cold water
V1,2,3,4 : Valve

TECHNICAL DRAWINGS

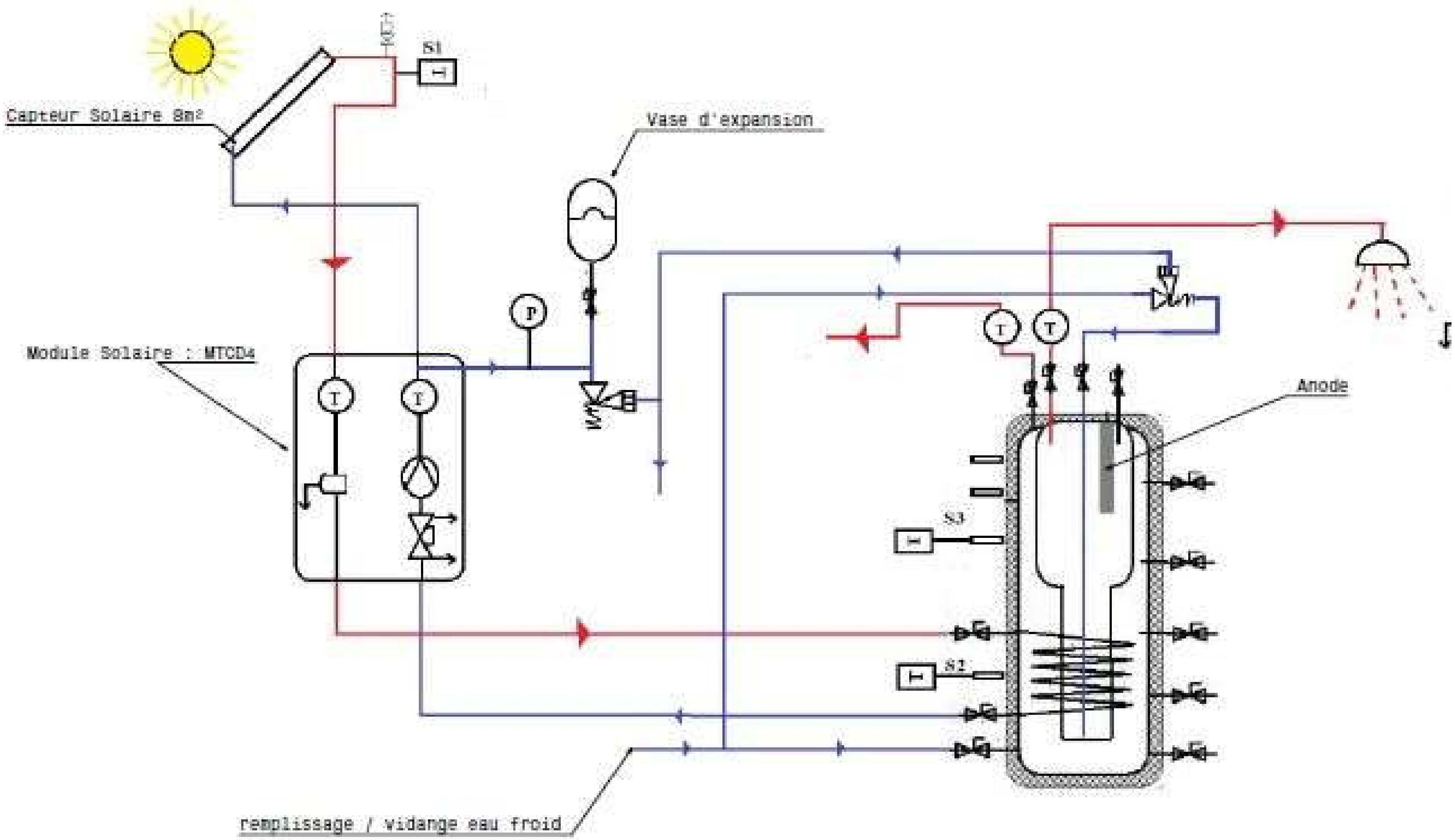
Hydraulic scheme of a forced circulation system



Example 1: Domestic hot water application

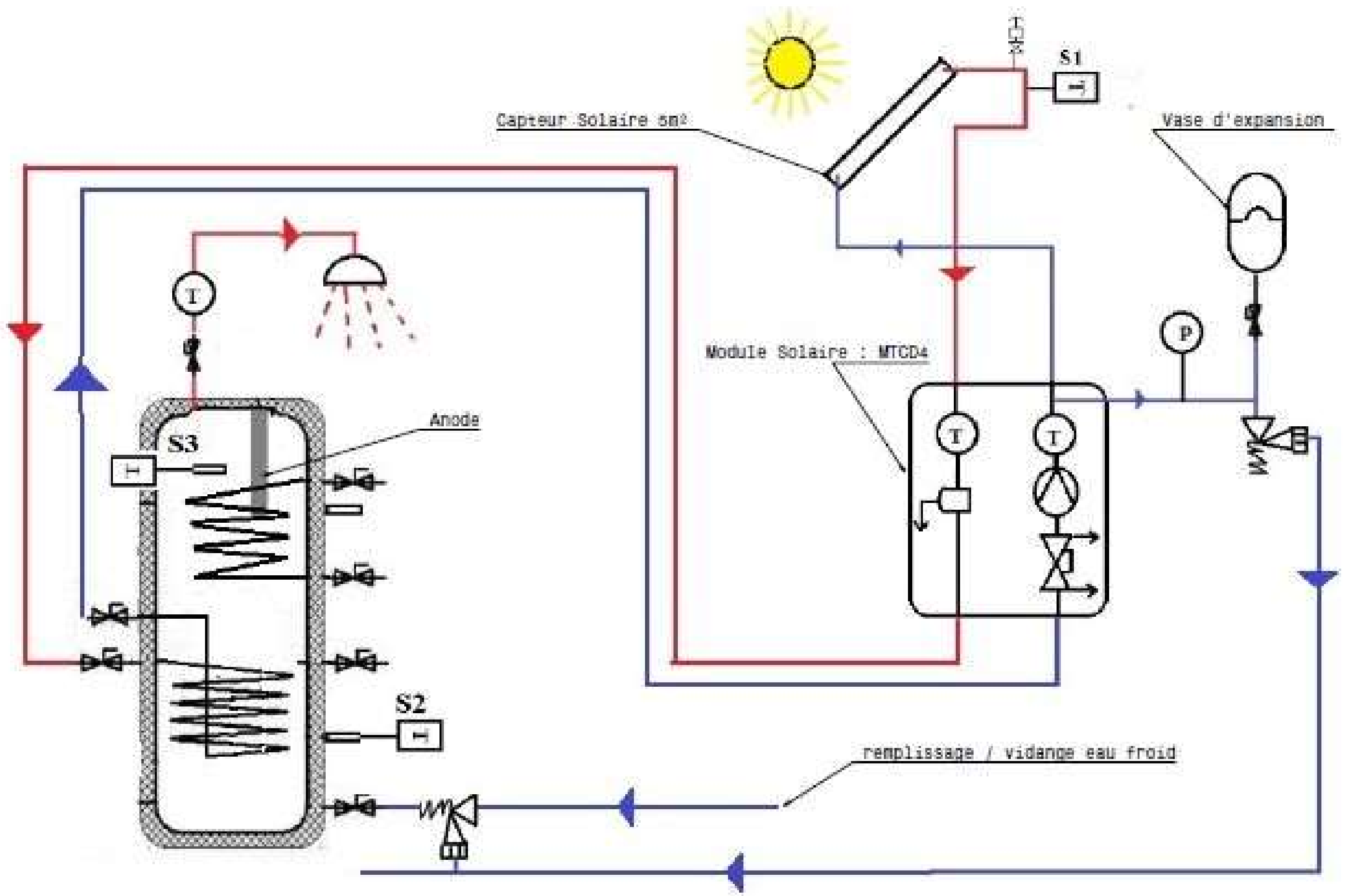
TECHNICAL DRAWINGS

Hydraulic scheme of a forced circulation system



Example 2 : Domestic hot water + heating application

TECHNICAL DRAWINGS
Hydraulic scheme of a forced circulation system



Example 3 : with two internal heat exchanger

(one for the solar primary circuit and the other for Gas boiler backup)

TECHNICAL DRAWINGS
Pipe specification

Characteristics :

- To resist at high temperature and the corresponding pressures
- The common material used is copper
- The use of galvanized steel is to be avoided
- Plastic or multilayer tubes are prohibited for temperature higher than 70 °C
- Insulation is fundamental to conserving heat energy
- The insulation of the external pipes have to resist to UV light

Recommendation diameter sizes:

	Tank type & capacity	Cupper piping
Indicative proposed diameters	180 - 200 L	12/14
	300 L	14/16
	400 L	16/18
	500 L et plus	18/20 ou 20/22

TECHNICAL DRAWINGS
Pipe types

Mild steel

Stainless steel

Copper

Multilayer (cold side)

SWH:
Site survey

Training of SWH installer & maintainer

Solar Water Heaters
Site survey

Objective:

- ✓ Be informed on SWH components installation
- ✓ Have knowledge on main preparatory activities
- ✓ Have detailed parameters on installation
- ✓ How to prepare SWH installation in site?

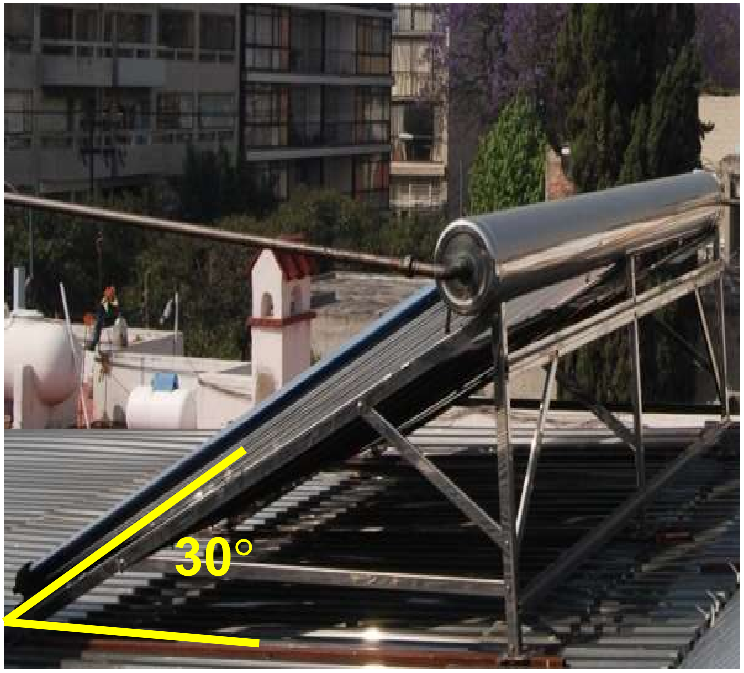
Duration

- ✓ 0:30 hour
- ✓ From : 15:00 to 15:30
- ✓ Close phones
- ✓ Don’t speak to each other

PERFORMS SITE SURVEY
Parameters optimizing the location

Orientation and angle tilt

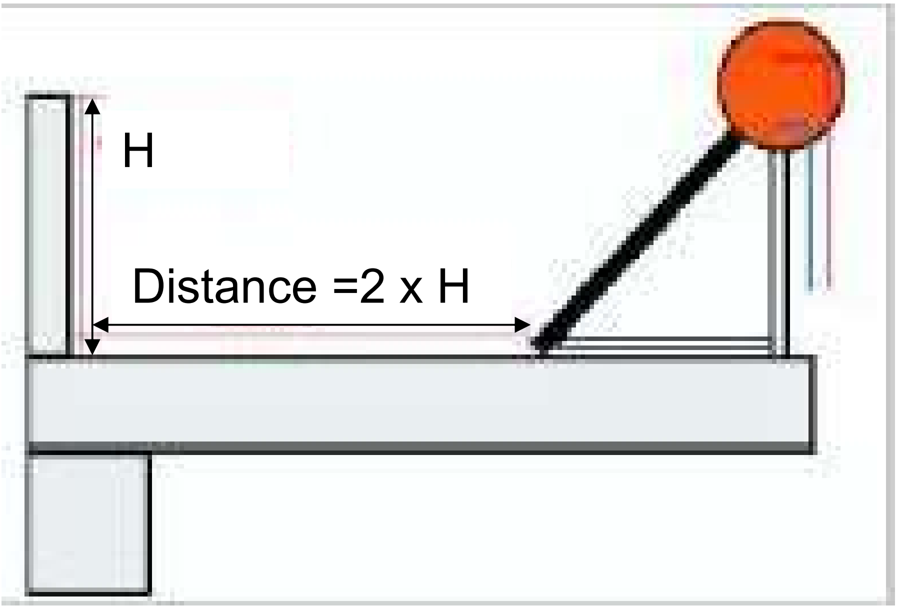
- In the Northern Hemisphere, the optimal orientation is facing south: **Azimut 0°**
- Optimal angle tilt = Location latitude = **30°** **(for Egypt case)**



PERFORMS SITE SURVEY

Parameters optimizing the location

Shading

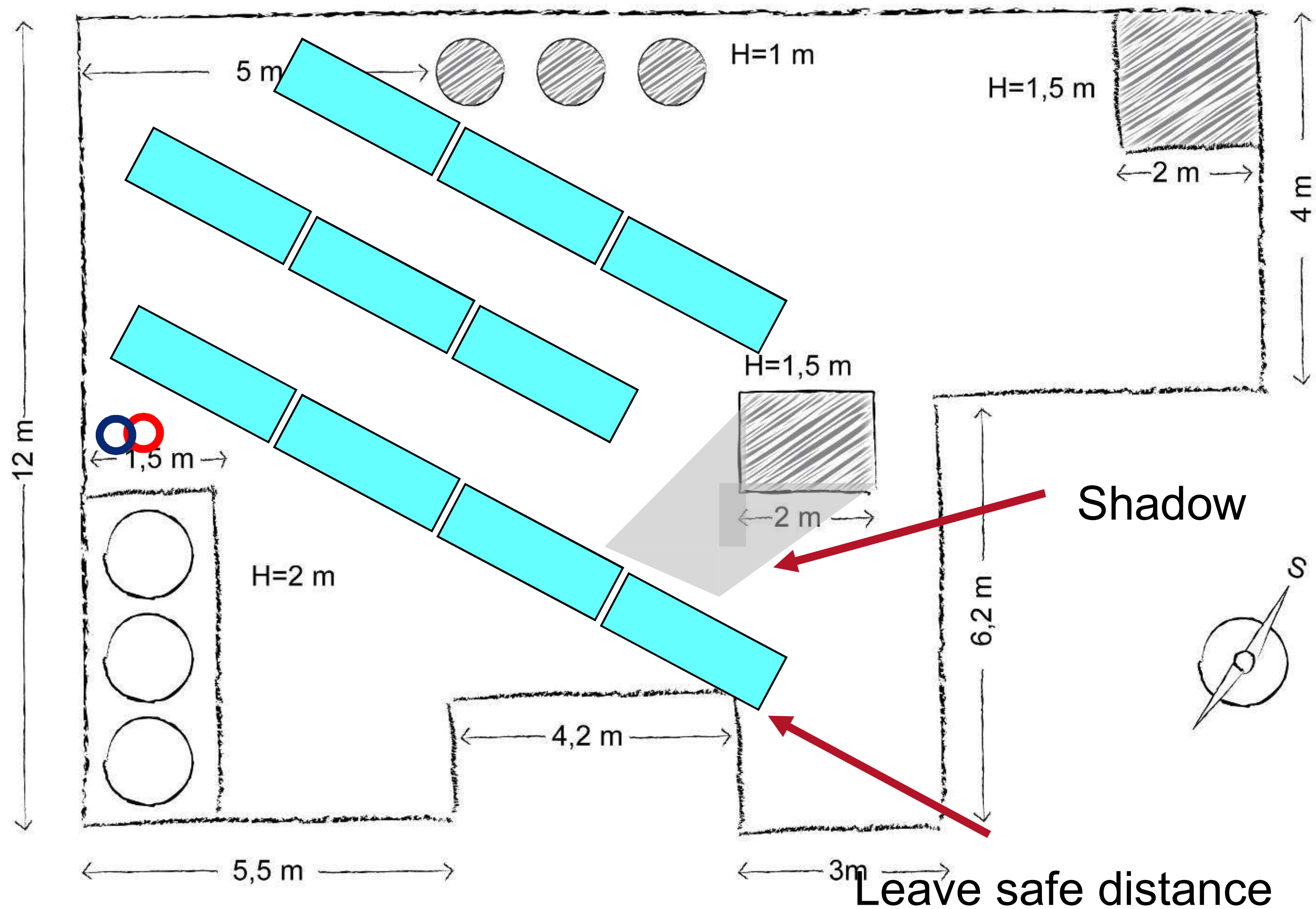


Minimum distance to avoid shading : 2xH

PERFORMS SITE SURVEY

Parameters optimizing the location

Shading

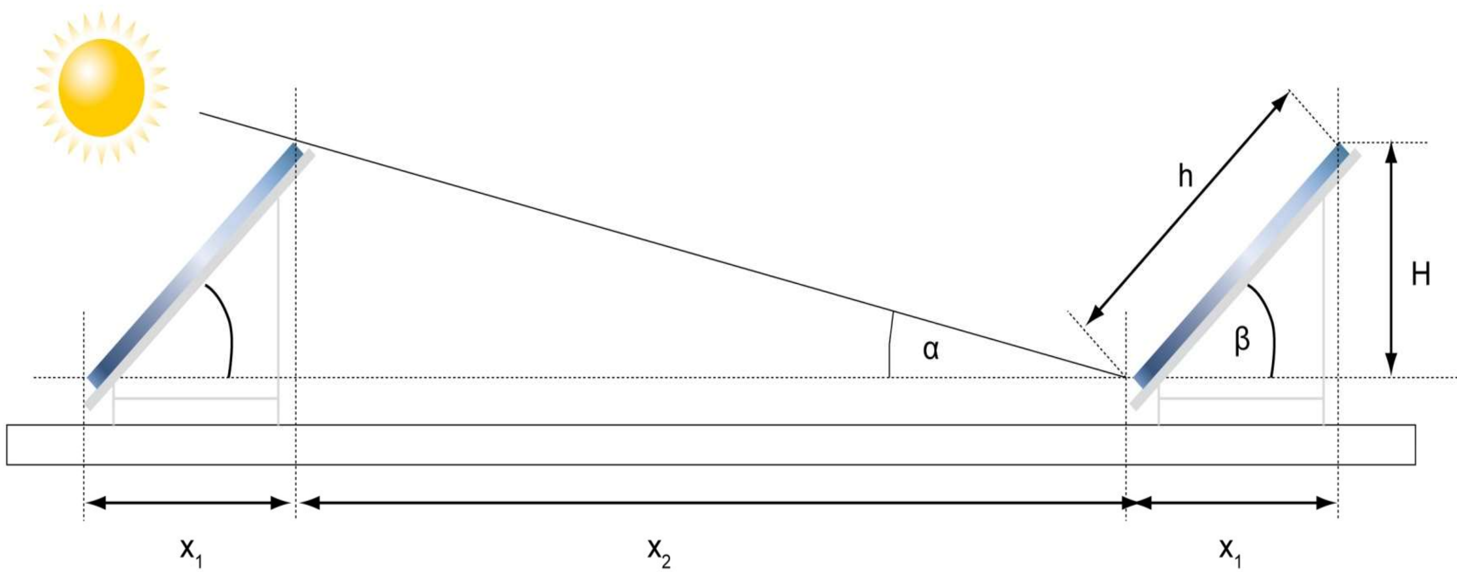


Leave safe distance for maintenance needs and circulation

PERFORMS SITE SURVEY

Parameters optimizing the location

Collectors Auto Shading



Height $H = h \cdot \sin \beta$

Length $x_1 = h \cdot \cos \beta$

$\tan \alpha = H / x_2 \quad \rightarrow \quad x_2 = H / \tan \alpha$

Minimum distance between collectors row for avoiding collectors shading is X_2

PERFORMS SITE SURVEY

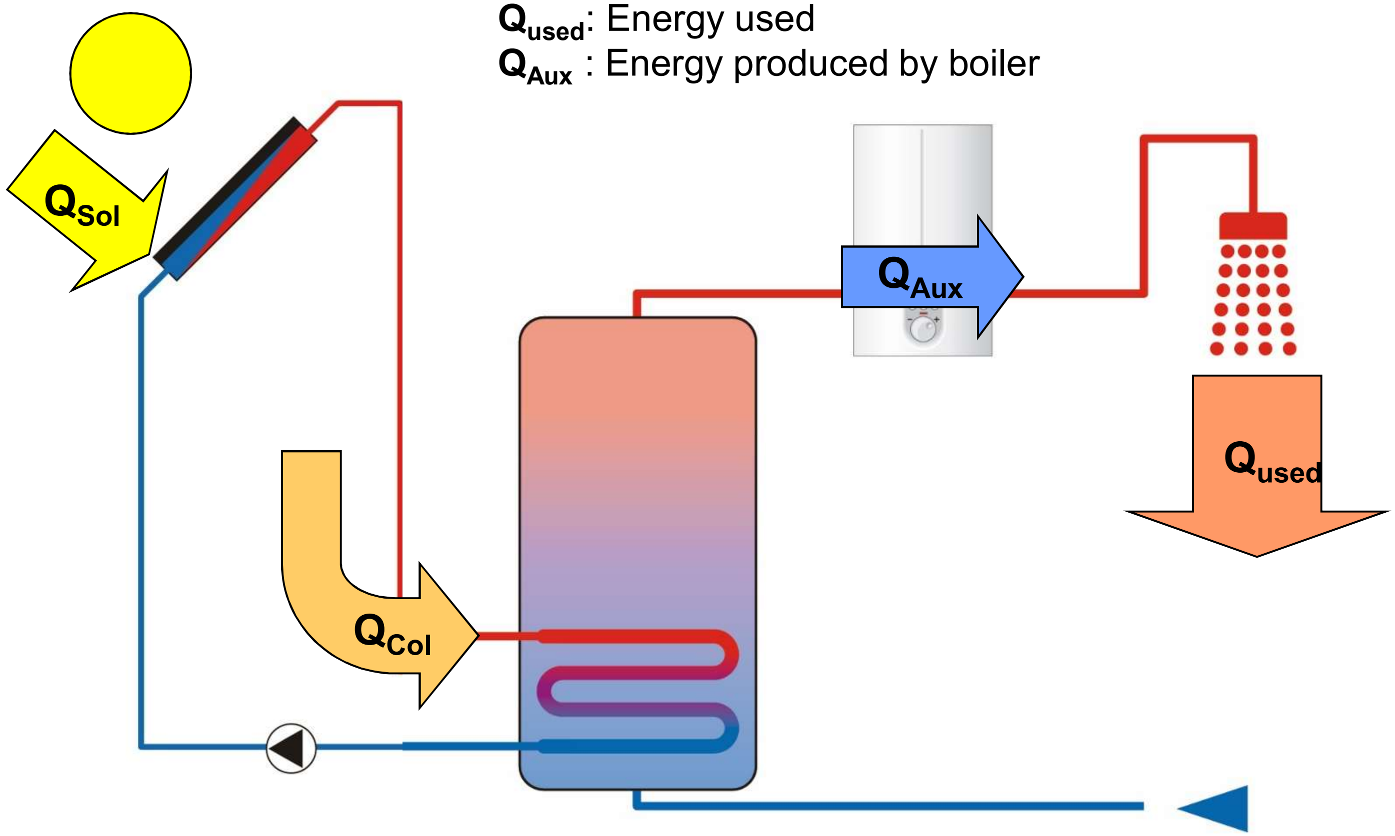
Parameters optimizing the performance

Existing parameters

- ❑ Close to a water evacuation point
- ❑ Take into account existing sanitary water heating equipment (wall-mounted boiler, electric water heater, etc.) and the distribution scheme
- ❑ Check the energy or fuel used (natural gas, LPG, electricity, ...)
- ❑ Take into account existing piping
- ❑ Check the customer needs

PERFORMS SITE SURVEY
Solar efficiency

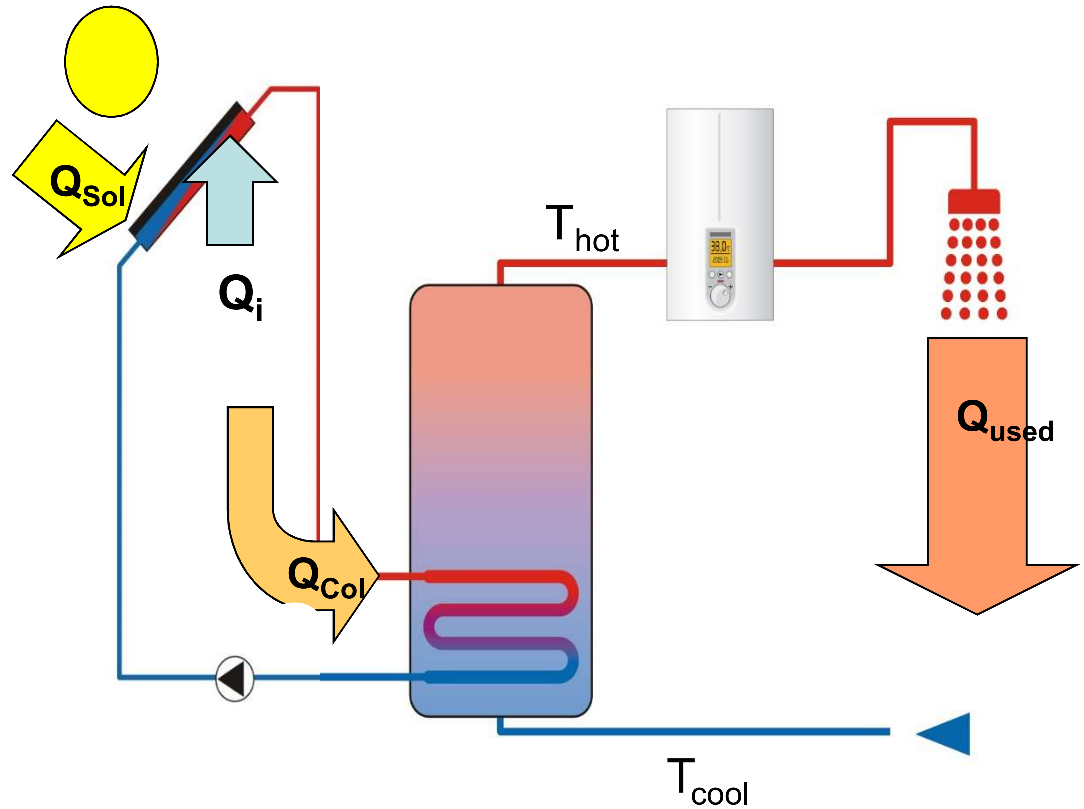
Q_{Sol} : Solar energy received by collectors
Q_{Col}: Energy converted
Q_{used}: Energy used
Q_{Aux} : Energy produced by boiler



$$\text{Solar efficiency } (\eta) = \frac{Q_{Col}}{Q_{Sol}}$$

PERFORMS SITE SURVEY
System efficiency

Qi : Energy produced by collectors

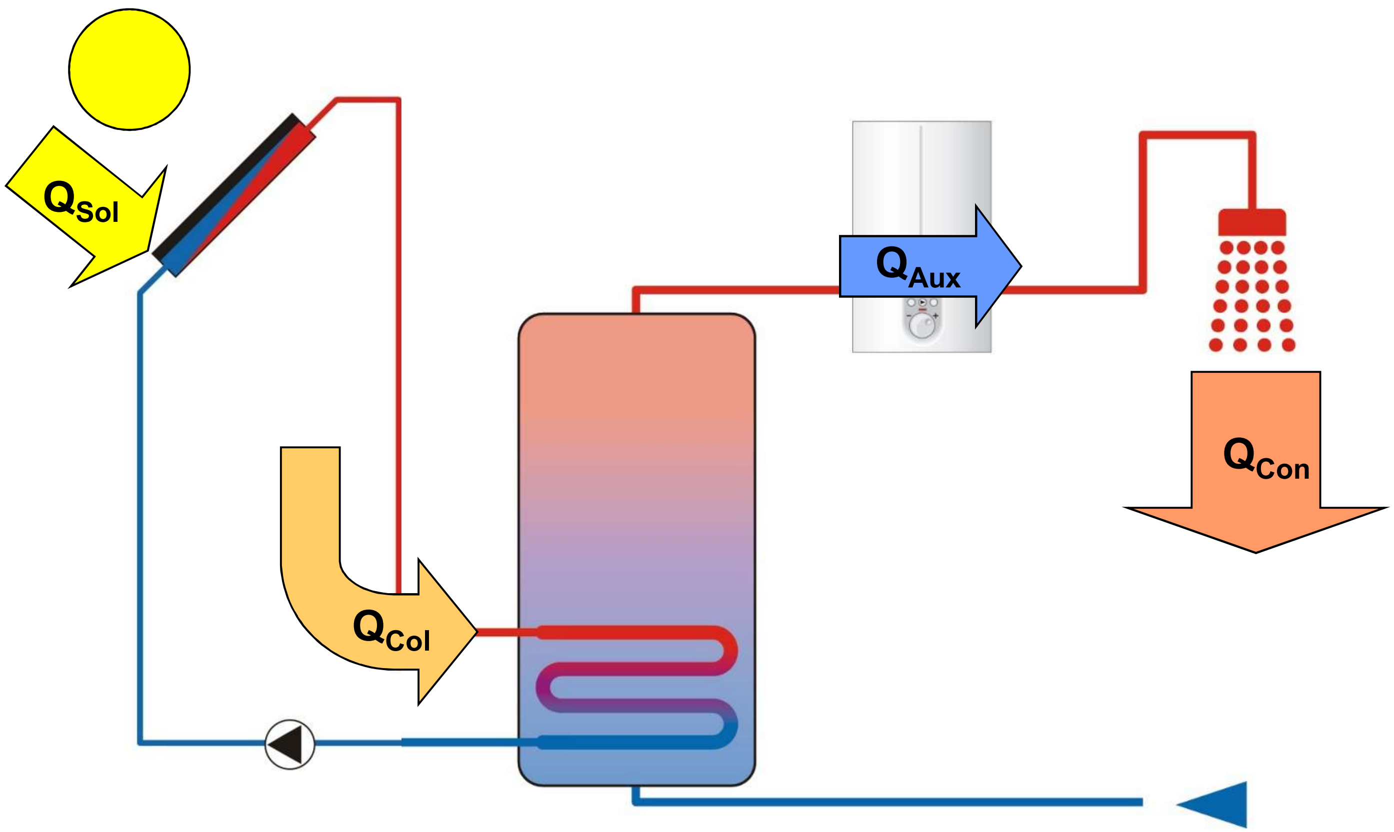


System efficiency = collector efficiency. Storage efficiency. Workpipe thermal effciency

$$\eta_{syst} = \eta_{col} \cdot \eta_{storage} \cdot \eta_{pipe}$$

PERFORMS SITE SURVEY
Solar fraction

CS (solar fraction between 60-90%)



$$\text{Solar Fraction : CS} = \frac{Q_{Col}}{Q_{Col} + Q_{Aux}} = \frac{Q_{Col}}{Q_{Con}}$$

SOLAR Heating
for Industrial Process
Together Toward Efficient Production

SWH: Installation techniques

Training of SWH installer & maintainer

Ministry of Trade & Industry
وزارة التجارة والصناعة

UNIDO

ENCPC
Egypt National Cleaner Production Center

gef

Solar Water Heaters
Installation techniques

Objective:

- ✓ Be informed on SWH components installation techniques
- ✓ Have knowledge on main preparatory tasks
- ✓ Have detailed parameters on installation
- ✓ How to install SWH in site?

Duration

- ✓ 1:00 hour
- ✓ From : 15:30 to 16:30
- ✓ Close phones
- ✓ Don’t speak to each other

Installation techniques
Preliminary visit

- ❑ Comply with the SWH quality charter :
  - Recommend eligible equipment.
  - Provide advice and assistance to the client
  - Submit a detailed offer, the warranty conditions including a service and maintenance contract
  - Etc.

- ❑ Collect the necessary information (occupants, existing equipment,…)

- ❑ Submit an offer

- ❑ Agree on funding arrangements

Installation techniques
SWH selection and sizing

The following table presents the values that can be used as a first estimation for individual SWH depending on occupants house number:

Occupants house number	1 or 2	3 or 4	5 or 6	7 and +
Tank volume without backup (liters)	100-150	150-250	250-350	350-500
Tank volume with backup (liters)	150-250	250-400	400-500	550-650
Collector area (m2)	2-2.5	2-6	3-8	4.5-10

Installation techniques
SWH selection and sizing

The following table presents the required collector area depending on daily hot water demand:

Demand			Required Collector Area			
Daily hot water demand		*Daily Energy*	*Flat plate collector type*			*Evacuated tube type*
(Litres)	(m^3)	(kWh/day)	Actual (m^2)	Available (m^2)	No. of collectors ($2m^2$)	(m^2)
100	0.1	5.3	1.5	2	1	1
150	0.15	7.9	2	2	1	1.5
200	0.2	10.5	3	4	2	2
300	0.3	15.8	4	4	2	3
400	0.4	21.0	6	6	3	4
500	0.5	26.3	7	8	4	5
600	0.6	31.5	8	8	4	6
700	0.7	36.8	10	10	5	7
800	0.8	42.0	11	12	6	8
1000	1	52.5	14	14	7	10
1200	1.2	63.0	16	16	8	12

Installation techniques
Safety and protection equipment

Safety shoes

Work glove

Pharmacy box

Installation techniques
Installation equipment

Manual banding machine
(For piping design)

Descaling pump
(For scale removal inside pipe in maintenance process)

Gaz blow pipe
(For welding pipes)

oxyflame” bottle and/or express-type
blowtorches for LPG welding

Scale for installation and manipulation

Installation techniques
Installation equipment

Cord diameter 25 mm and/or any appropriate lifting means (For handling and transport SWH components)

Drill a hit
(for mounting structure support)

Large model puncher equipped with appropriate strands of different diameters for drilling walls 50 cm thick
(For drilling walls if necessary)

Installation techniques
Tools and measuring equipment

Plumping tool box
(for mounting and installation)

Compass
(for fixing the good orientation)

Digital thermometer
(for water temperature measurement)

Flowmeter
(for water flow measurement)

Installation techniques
Step 0 :Preliminary works and verification

- ❑ Ensure the presence of expectations in accordance with the preliminary visit recommendations

- ❑ Choose a SWH location far from obstacles and close to a water evacuation

- ❑ Fix the orientation using a compass (due south)

Installation techniques : Flat plate case
Step 1 :Support structure mounting (1)

Lateral triangular supports are assembled on the floor

Installation techniques : Flat plate case
Step 1 :Support structure mounting (2)

Fixing Track collector on triangular support - Structure reinforcement by X back supports

Installation techniques : Flat plate case
Step 2: Collector mounting (1)

Fixing and positioning
collector on the frame

Fixing collector at frame bottom

Fixing collector at frame top

Installation techniques : Flat plate case
Step 2: Collector mounting (2)

Drainage holes perforation to avoid effects harmful condensation in the collectors

Installation techniques : Flat plate case
Step 3: Tank mounting (1)

Fixing the rear tank support

Fixing tank on the frame

Installation techniques : Flat plate case
Step 3: Tank mounting (2)

Tank centered position

Tightening tank fixation

Installation techniques : Flat plate case
Step 4: Concrete slabs fixation & overall stability check (1)

Tightening the X back fixation after tank mounting

Installation techniques : Flat plate case

Step 4: Concrete slabs fixation & overall stability check (2)

Concrete fixing slabs with horizontal alignment verification of entire assembly

N.B : Use mortar to fix the slabs on the floor and screws to fix the frame on the slabs

Installation techniques : Flat plate case
Step 5: Hydraulic and electrical connections

Safety group connection

The valve have to be mounted in position vertical to avoid blockage by limestone

Installation techniques : Flat plate case
Step 5: Hydraulic and electrical connections

Collector-Tank cold water piping connection

Connection and tightening

Installation techniques : Flat plate case
Step 5: Hydraulic and electrical connections

Collector-Tank hot water piping connection

Connection and tightening

Installation techniques : Flat plate case

Step 5: Hydraulic and electrical connections

Shaping , cutting and welding hydraulic connection

. The hot water piping have to be insulated

Installation techniques : Vacuum tubes case
Step 2: Reflectors fixing

Fixing Reflectors on frame support

Installation techniques : Vacuum tubes case
Step 3: collars insertion fixing

Fixing collars insertion on frame support

Installation techniques : Vacuum tubes case
Step 4: Tank mounting

Fixing tank on the frame

Installation techniques : Vacuum tubes case
Step 4: Vacuum Tubes mounting



Fixing up vacuum tubes in manifold inside the tank

Fixing bottom tubes in aluminum slide

Installation techniques : Forced circulation case
Step : Tank installation

- The storage tank have to be installed in a technical local
- It would ideally be installed as close to the array collectors as practical in order to minimize heat loss in piping runs
- The distance between the tank and any wall should be minimum 50 cm
- It need minimum 60 cm between the ceiling and the top of the tank in order to conveniently replace the magnesium anode rod

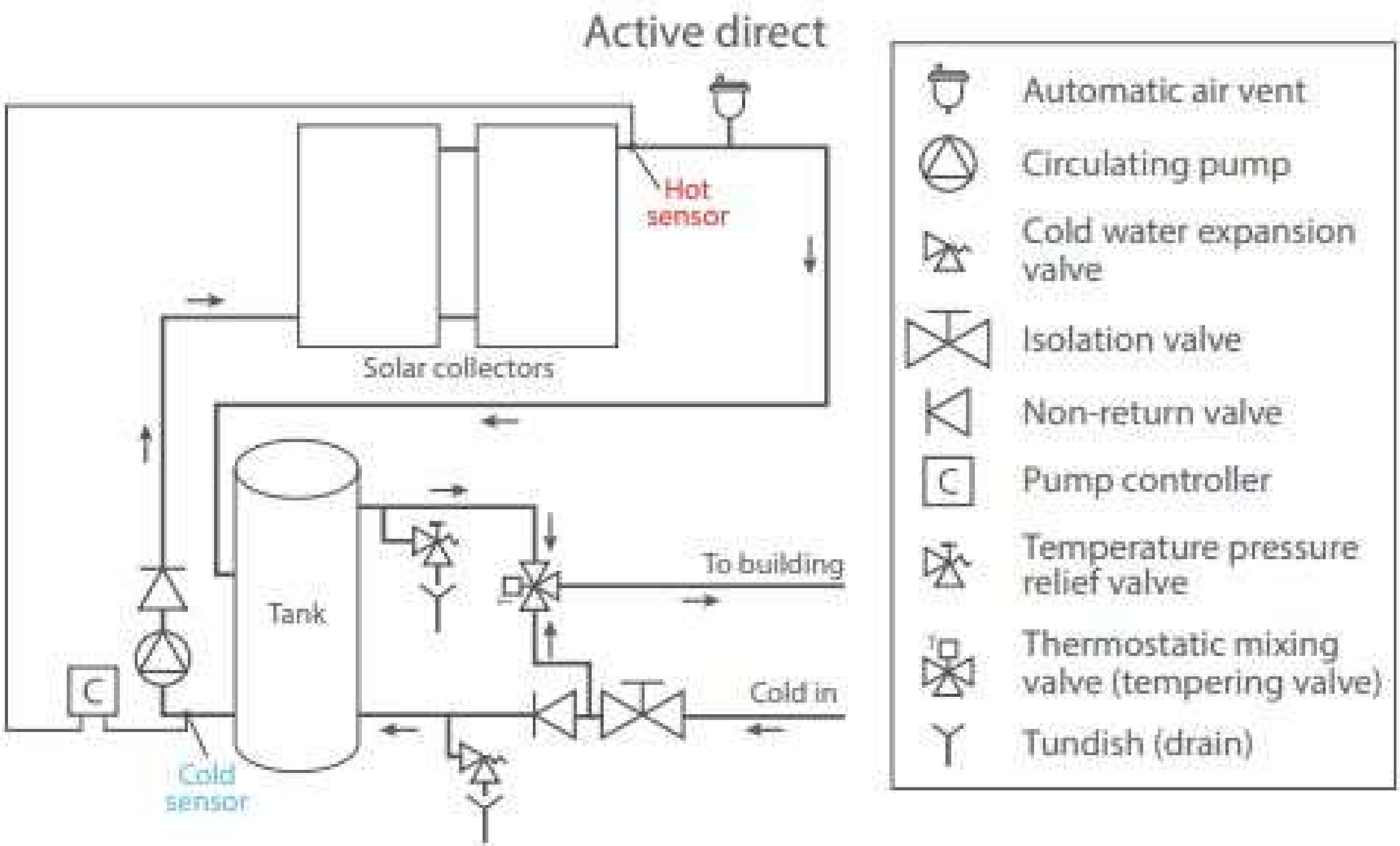
Installation techniques : Forced circulation case
Step : Pump station installation

- The pump station incorporate pump, a differential controller, a flow meter, gauges and non-return valves in general

- It must be installed onto the wall and the pump wired to the cold line, which runs between the lower part of the tank to the lower inlet of the collector(s)

- Differential controller function : measure the temperature at the solar collector and the storage tank to determine whether pump operation is appropriate or not.

Installation techniques : Forced circulation case
Step : Safety devices installation



The valves should be installed in such a way that there is ample accessibility for maintenance and troubleshooting

Installation techniques : Forced circulation case
Step : Safety devices installation

- The solar system must have isolation valves – one on each side of the solar loop. An isolation valve should be provided between the pump and the tank on the feed line and between the non return valve and the tank on the return line.

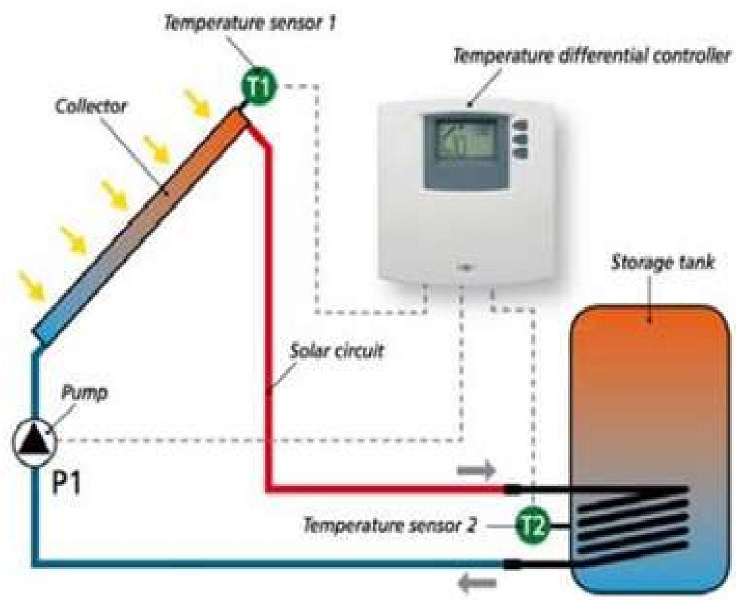
- Drain valves should be provided on both sides of the collector loop. Drain valves should always be readily accessible.

- If a standard “mixing” valve is to be installed, be sure it is below the top of the tank

- Thermometer wells on both the inlet and outlet sides of the solar loop are desirable.

Installation techniques : Forced circulation case
Step : Temperature sensors installation

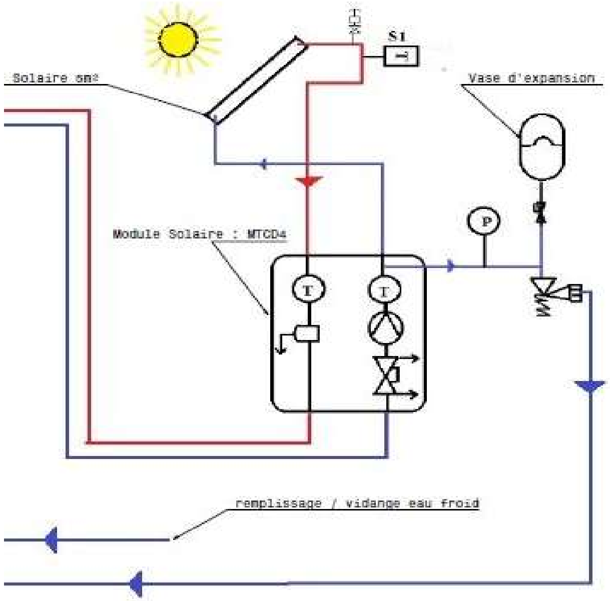
- The tank sensor should be located on the storage tank as close as possible to the bottom
- The high-temperature sensor have to be placed on the outlet pipe of the solar collector
- All sensors must be mounted according to manufacturer's specifications
- Connections for sensors should be made with silicone-filled wire nuts or telephone style waterproof connections. They should be coated weather tight with sealant and protected from exposure to sunlight



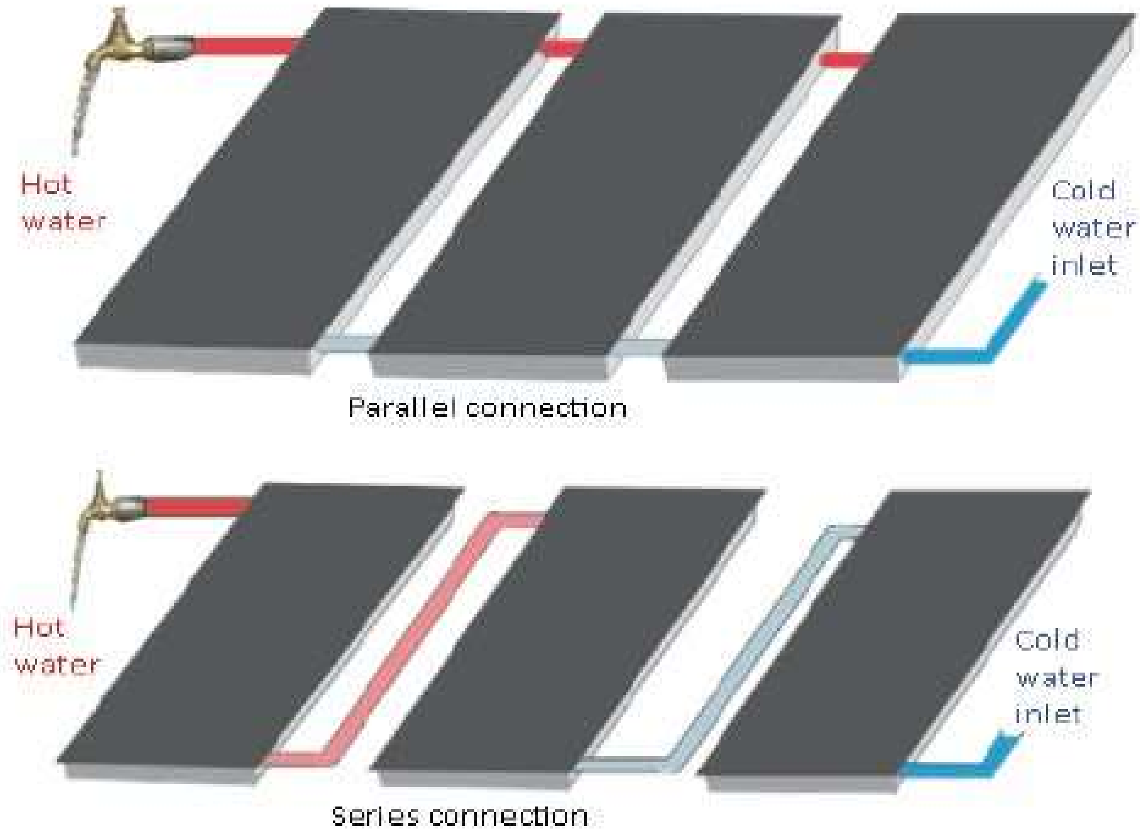
Installation techniques : Forced circulation case
Step : Expansion tank installation

- ❑ Mount the expansion tank in a convenient location close to the pump station
- ❑ connect the expansion tank connection line ends to the pump station

- ❑ Connect the expansion tank on the cold line



Installation techniques :
Series or parallel collectors installation



The maximum number of collectors in series or parallel have to be recommended by the manufacturer

SOLAR Heating for Industrial Process

Together Toward Efficient Production

SWH: Maintenance and repair Thermosiphon systems

Training of SWH installer & maintainer

Ministry of Trade & Industry

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Solar Water Heaters
Maintenance and repair

Objective:

- ✓ Be informed on SWH components maintenance
- ✓ Have knowledge on main SWH faults
- ✓ Have detailed tasks on M&R
- ✓ How to prepare maintenance of SWH in site?

Duration

- ✓ 0:30 hour
- ✓ From : 16:30 to 17:00
- ✓ Close phones
- ✓ Don’t speak to each other

Maintenance & repair
Preventive maintenance Check list

In the event of maintenance or repair, cut off the cold water supply and electricity before taking any action

Component inspection	Action(s)
Flat plate Collector/ evacuated tube glazing and seals	Look for cracks in the collector/ evacuated tube glazing, and check to see if seals are in good condition (condensation case)
Plumbing, pipework, and wiring connections	Look for fluid leaks at pipe connections. Check pipe connections and seals. pipes should be sealed with a mastic compound. All wiring connections should be tight
Piping and wiring insulation	Look for damage or degradation of insulation covering pipes and wiring
Roof penetration	Flashing and sealant around roof penetrations should be in good condition.
Support structures	Check all nuts and bolts attaching the collectors to any support structures for tightness Check the metal condition (anti corrosion paint if necessary)
Safety valves (safety group, safety valve)	Make sure the valve is not stuck open or closed Check the safety group by turning the purge button. (it is normal for the valve to "drip", in case of high water temperature)

Maintenance & repair
Preventive maintenance Check list

Component inspection	Action(s)
Antifreeze fluid	Check and / or change the antifreeze fluid in the closed circuit. The frequency of this operation is often reported in the supplier's manual
Storage tank	Regular drain and clean the Tank storage to prevent the risk of bacterial proliferation Check for cracks, leaks, rust, or other signs of corrosion
Magnesium anode	Check the anode state. When the anode reaches a level of wear, its diameter becomes very small, which causes leaks at the clamping nut. This problem is accelerated by the non earthing of the anode (quite frequent case)
Back up (electrical case)	Check any damage to the sleeves, electrical cables Check that the electrical connections and grounding are in good condition. Check the thermostat setting Check the condition of the electric resistance (scale deposit)

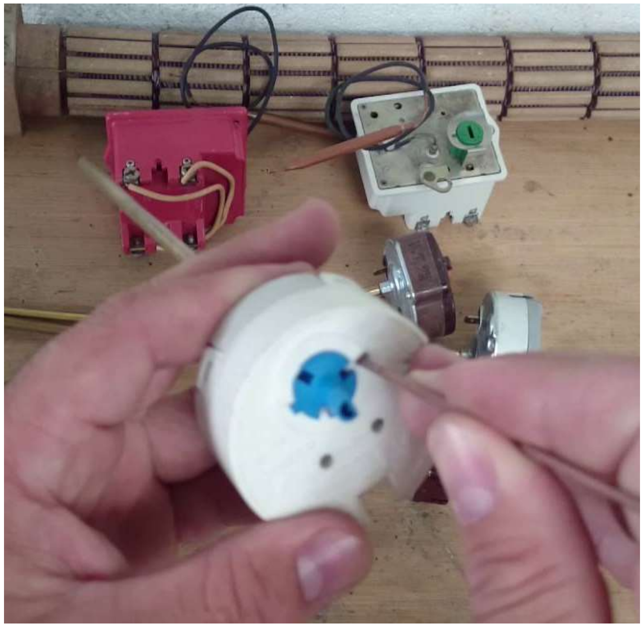
Maintenance & repair
Preventive maintenance examples

Clean dirty collector

Condensation holes under the glass

Maintenance & repair
Preventive maintenance examples

Purge button operation



Thermostat setting

Maintenance & repair
Preventive maintenance examples

Electrical resistance control and replacement

Limestone extraction

Maintenance & repair
Preventive maintenance examples

Magnesium anode control and replacement

Collector drain hole control

Maintenance & repair
Curative maintenance

Clean, descale or replace if necessary :

- ❑ Piping connection
- ❑ Tank
- ❑ Joint
- ❑ Safety group
- ❑ Tube grid collector
- ❑ Magnesium anode
- ❑ Electrical resistance
- ❑ Thermostat
- ❑ Vacuum tubes (for vacuum case)
- ❑ Fill antifreeze fluid (for indirect system)
- ❑ Expansion vessel (for indirect system)

Maintenance & repair
Troubleshooting: Thermosiphon case

Issue	Thermosiphon Direct System		Thermosiphon Indirect System		Cause (s)	Corrective Action (s)
Collector type	**Flat Plate**	**Evacuated Tube**	**Flat plate**	**Evacuated Tube**		
Leakage at the connections	X	X	X	X	Connections clogged with limestone	Clean/replace connections
	X	X	X	X	Defective joint	Replace joint
Not hot water	X				Tube grid collector clogged with limestone	Descale and clean the tube grid collector
			X	X	Lack of antifreeze fluid	Control the level/add antifreeze fluid
			X	X	Leak at expansion vessel	Replace expansion vessel and add antifreeze fluid
	X	X	X	X	Absence or bad state of pipework insulation	Replace/Insulate hot water canalization
		X		X	Vacuum losses in vacuum tube	Replace defective evacuated tubes
	X	X	X	X	Safety group blocked at open position	Clean/replace safety valve

Maintenance & repair
Troubleshooting : Thermosiphon Case

Issue	Thermosiphon Direct System		Thermosiphon Indirect System		Cause (s)	Corrective Action (s)
Collector type	**Flat Plate**	**Evacuated Tube**	**Flat plate**	**Evacuated Tube**		
Not hot water in winter	X	X	X	X	Backup electrical resistance doesn't work	Clean/replace electrical resistance
	X	X	X	X	incorrectly set temperature at thermostat	Set the temperature at 50°C
	X	X	X	X	Defective thermostat	Replace thermostat
Not hot water pressure	X	X	X	X	Safety group blocked at closed position	Clean/replace safety valve
	X	X	X	X	Inlet hot water flow pipe clogged with limestone	Clean/remove limestone
Humidity in collector	X		X		Defective collector joint	Replace defective joint
	X		X		Condensation holes are blocked	Unblock holes

Maintenance & repair
Troubleshooting: Thermosiphon case

Issue	Thermosiphon Direct System		Thermosiphon Indirect System		Cause (s)	Corrective Action (s)
Collector type	Flat Plate	Evacuated Tube	Flat plate	Evacuated Tube		
Lack of hot water pressure	X	X	X	X	Significant pressure losses Large scale deposit Pressure fault in network	Descale and purge collectors and Tank Check and clean safety group
High temperature difference between collector and water tank	X				Tube grid collector clogged with limestone	Descale and purge tube grid collector
			X	X	Heat exchanger covered with limestone	Descale and clean heat exchanger
Noisy installation	X	X	X	X	Pressure drop or charged water	Purge and increase pressure if necessary
Back up electrical resistance doesn't work at the cold season start	X	X	X	X	Thermostat switched off for safety (Above 90°C thermostat deactivates electric resistance)	Restart thermostat

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Thermosiphon system installation

Training of SWH installer & maintainer

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DAY2 – PRACTICAL PART
Thermosiphon system installation

Objective:

- ✓ Practice the knowledge of the first day
- ✓ Improve skills of installers
- ✓ Get trained on the installation
- ✓ Use the SWH manual

Duration

- ✓ 6 hours with one coffee break and one lunch break
- ✓ From 9:00 to 15:00
- ✓ Close phones
- ✓ Don't speak to each other

YE1
YE2

DAY2 – PRACTICAL PART
Thermosiphon system installation

- ❑ SWH pre-installation preparation in site
- ❑ SWH components inspection in site
- ❑ Steel structure assembling
  - ✓ Structure for collectors
  - ✓ Structure for tank
  - ✓ Stone concrete fixation
- ❑ Collector installation
  - ✓ Individual collector
  - ✓ Series collectors

For evacuated tube and flat plat **YE1**
Yahia El-Masry, 04-Aug-20

Please put pictures for the steps that you are going to do in the installation **YE2**
Yahia El-Masry, 04-Aug-20

DAY2 – PRACTICAL PART
Thermosiphon system installation

- ❑ Tank installation
  - ✓ Horizontal positioning
  - ✓ Water pressure

- ❑ Connection between different components
  - ✓ Cold water connection
  - ✓ Hot water connection

- ❑ Installation of accessories
  - ✓ Safety valve
  - ✓ MG Anode
  - ✓ Thermostat
  - ✓ Backup system
  - ✓ Electrical connection
  - ✓ Electrical earth

DAY2 – PRACTICAL PART
Thermosiphon system installation

Organization:

- ✓ Work in small groups
- ✓ Identify SWH components
- ✓ Identify necessary tools
- ✓ Follow the trainer instructions
- ✓ Follow the SWH manual of installation
- ✓ Respect safety requirements
- ✓ Have the individual safety equipment's

Commissioning Thermosiphon systems & best practices

Training of SWH installer & maintainer

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DAY2 – COMMISSIONING & BEST PRACTICES
SWH installation and maintenance

Objective:

- ✓ Why the commissioning is important?
- ✓ Best practices in SWH installation
- ✓ Best practices of SWH maintenance

Duration

- ✓ 2 hours
- ✓ From : 15:00 to 17:00
- ✓ Close phones
- ✓ Don’t speak to each other

COMMISSIONING
Filling and Rinsing

The hydraulic circuits filling depends on the SWH type :

- ❑ Direct system
- ❑ Indirect system
- ❑ Forced circulation system

Filling step have to take place for hours at low sunshine otherwise after covering the collectors to avoid thermal shocks

COMMISSIONING
Filling and Rinsing: Thermosiphon case

Direct system (open loop)

1. Open at least one hot water tap in the house
2. Open the safety group cold water inlet to fill the tank and collector
3. Leave the hot water tap open until the air bubbles have completely disappeared, then close and allow the tank to build up pressure
4. Check any leakage on the pipeline
5. Open the hot water tap again to check that all air is purged from the system

COMMISSIONING

Filling and Rinsing : Thermosiphon case

Indirect system (close loop)

1. Follow the steps 1-4 of the direct system list to purge all air from the storage tank

2. In an indirect system, the working fluid solution (antifreeze) that is circulated may need to be filled in depending on the type of system. Follow manufacturer's instructions for filling collector loop with this antifreeze fluid. This generally involves cracking a nut or a fitting at the highest point in the collector loop to allow air to escape while antifreeze fluid is filled from a low point in the system. Antifreeze fluid is filled either by a bucket connected via a hose and held at height over the system, or with specialized manual pumps

3. Open the hot water tap again to check that all air has been purged from the system.

COMMISSIONING
Check list commissioning actions

- ❑ Visual inspection of the system installation and workmanship to ensure proper installation and that the area is left clean
- ❑ Ensure that there is no obstacle (building, tree, etc.) shading the solar collector or a part of it. Ensure ladders, scaffolds or safety tapes installed during installation are removed from the site. Any dug outs should also be filled up
- ❑ Verification of whether the installed components meet the stated specifications
- ❑ The system should be flushed out with cold water to ensure that any dirt inside the piping is removed.
- ❑ Ensure that there is no blockage and that the safety group, safety valve, Air vent and thermostatic mixing valve are properly installed and are easily accessible.
- ❑ Ensure that there is no air trapped inside the collector and the storage tank
- ❑ Testing for leaks should be done by carrying out a test run and pressurizing the system for at least 24 hours before handing over to the owner
- ❑ Verify that the back-up heater is working as required and confirm the correct operation of the thermostats and safety controls.

COMMISSIONING
Check list commissioning actions

- ❑ The controller should also function properly and be able to measure the output water temperature accurately
- ❑ Verify that the system is well insulated to reduce heat losses
- ❑ Check the fluid level for the closed circuit (indirect systems) and fill it, if necessary
- ❑ Check all the pipes and ensure they are well placed and adequately secured or clipped
- ❑ Verify that the various parameters such as the flow rate, pressure and temperature of the various components are as designed. The variable settings critical to the performance of the system are adjusted, set and recorded

Note: The electrical back up should be tested after the leak test is done and when the storage tank is full.

BEST PRACTICES
Installation and maintenance

Proscribed Practice	Good Practice
Bad practices	Best practices
Something to avoid	Something to copy
Negative design	Positive design
Bad connections	Good connections
Accidents	Prevent accidents
Not safety	Make safety
…..	…..

BEST PRACTICES
Transport & handling

Proscribed Practice

Good Practice

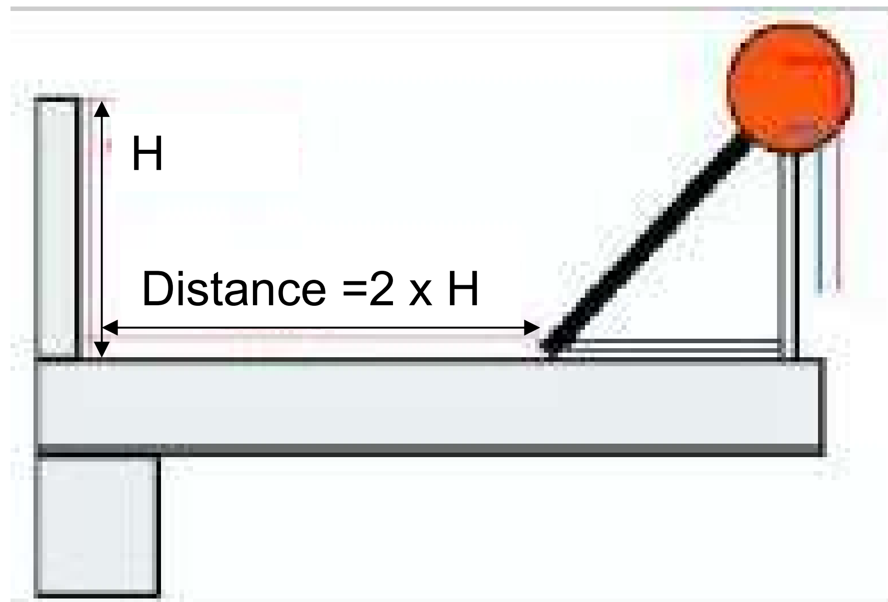
Have adequate handling and transport equipment (cord, ladder,…)

BEST PRACTICES
Shadow & orientation

Proscribed Practice

Good Practice

YE6



The minimum distance from the obstacle : 2 x obstacle hight

We need high resolution pictures **YE6**
Yahia El-Masry, 04-Aug-20

BEST PRACTICES
Piping insulation

Proscribed Practice

Good Practice

The hot water flow have to be insulated

BEST PRACTICES
Non-compliance of the electrical connection

Proscribed Practice

Good Practice

- Differential Circuit breaker :30 mA
- Minimum electrical cable section : 2.5 mm2

Respect the minimum amperage and minimum electrical cable section

BEST PRACTICES
Non-compliance of the electrical connection

Proscribed Practice

Good Practice

Respect the good wiring

BEST PRACTICES
Hot water piping material

Proscribed Practice

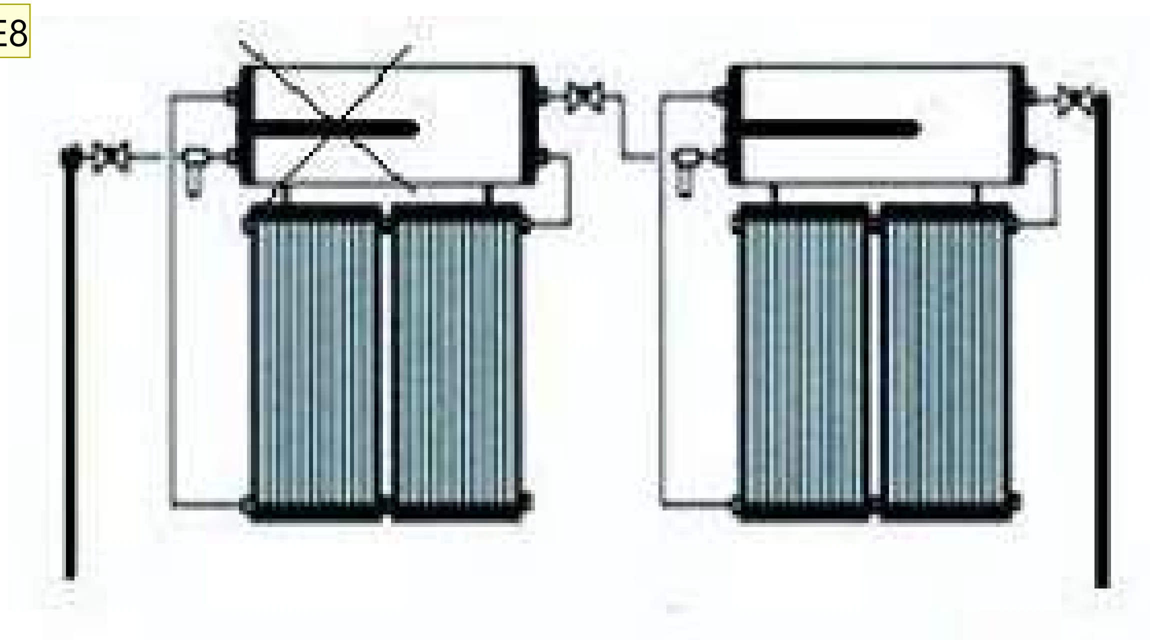
Good Practice

Multilayer material

Copper material

BEST PRACTICES
electrical backup position for SWH in serie

YE8



Cold Water

Hot Water

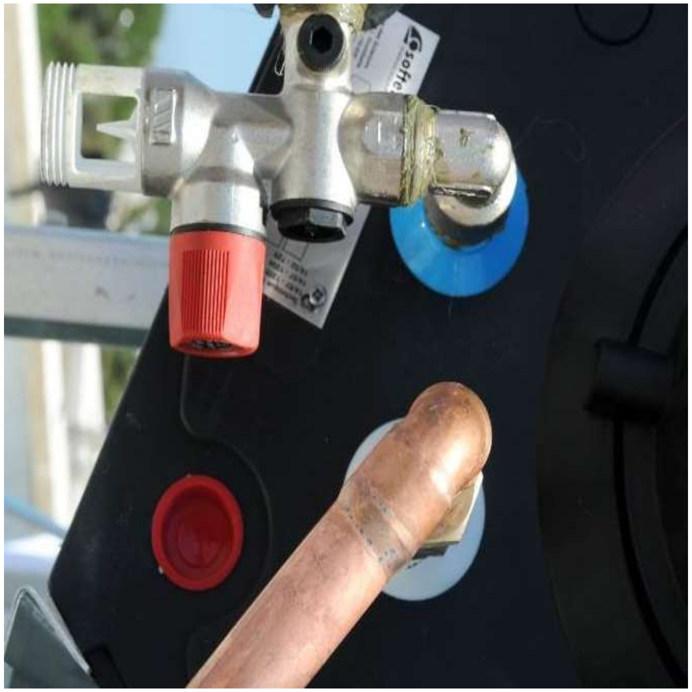
The electric backup will be installed on the last SWH

We need high resolution pictures | YE8
Yahia El-Masry, 04-Aug-20

BEST PRACTICES
Safety group position

Proscribed Practice

Good Practice



The safety group have to be mounted in vertical position for safety persons

BEST PRACTICES
Thermostatic Mixer Utility

Proscribed Practice

Good Practice

YE9

Use thermostatic mixer to save hot water and prevent accidental burns

We need high resolution pictures
Yahia El-Masry, 04-Aug-20

YE9

BEST PRACTICES
Concrete fixing slabs

Proscribed Practice

Good Practice

Use mortar to fix the slabs on the floor and screws to fix the frame on the slabs

BEST PRACTICES

Roof waterproofing

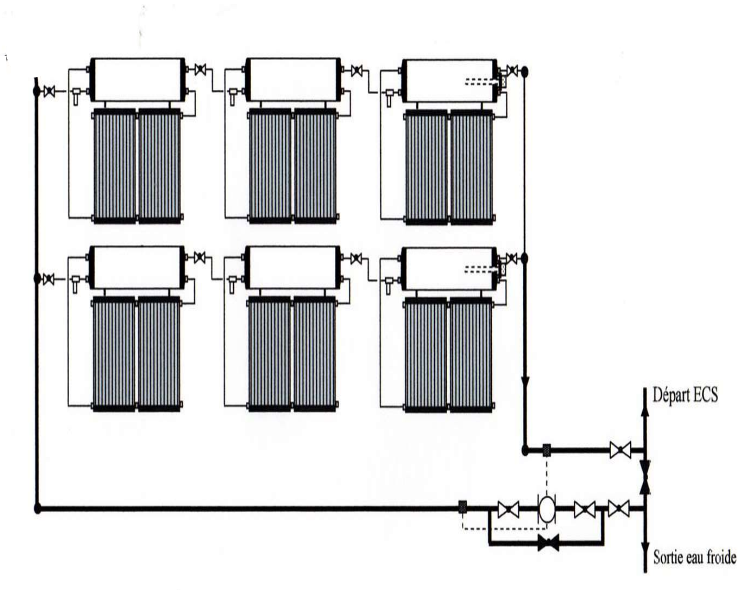
Proscribed Practice

Good Practice

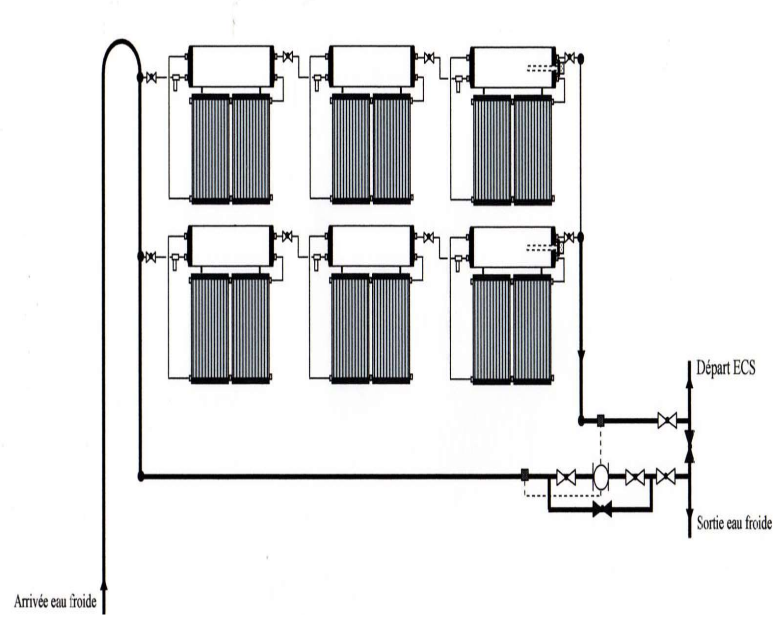
- Do not install the SWH directly on the roof waterproofing without mechanical protection
- Avoid fixing anchors or other means of fixing directly on the roof terrace
- Avoid waterproofing rising at the acroterion (extension of the façade wall to the roof terrace), and use rigid sleeves for all crossings of foundation walls.

BEST PRACTICES
Tickelman loop

Proscribed Practice



Good Practice



A series-parallel assembly must respect a set of rules, including the hydraulic balancing of the rows. The water passes through the least resistant circuit. So poor irrigation for the most distant rows

A series-parallel assembly in Tickelman loop way provides a better mass flow balance in circuit even for far rows

BEST PRACTICES
Waterproofing connection

Proscribed Practice

Good Practice

Teflon joint

Tow (hemp) joint

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SWH: Forced circulation systems

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DAY3 – SWH: Forced circulation systems
SWH installation and maintenance

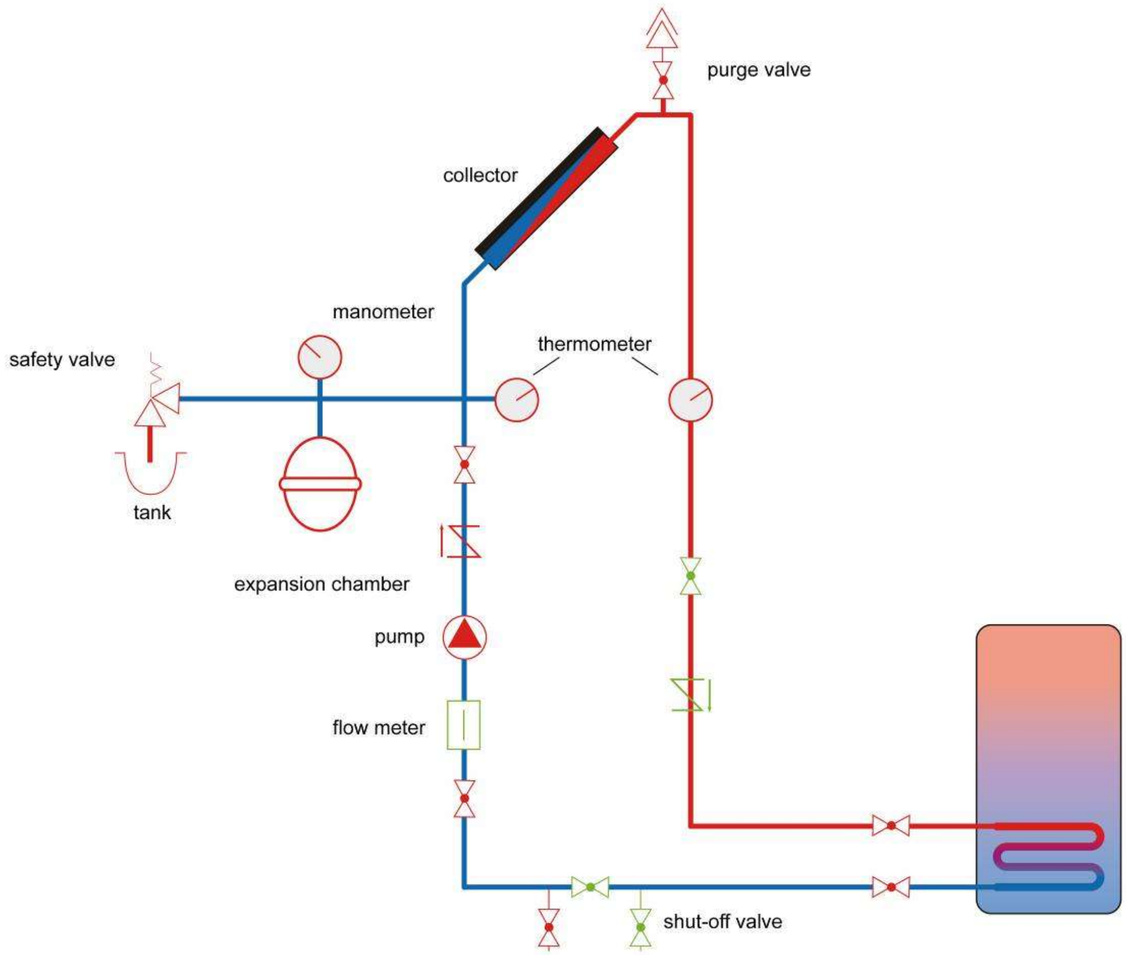
Objective:

- ✓ Why the forced circulation systems?
- ✓ Components of FSWH
- ✓ Best practices in installation and maintenance
- ✓ Best practices in commissioning

Duration

- ✓ 1:30 hours
- ✓ From : 9:00 to 10:30
- ✓ Close phones
- ✓ Don't speak to each other

FORCED CIRCULTION SWH
System components

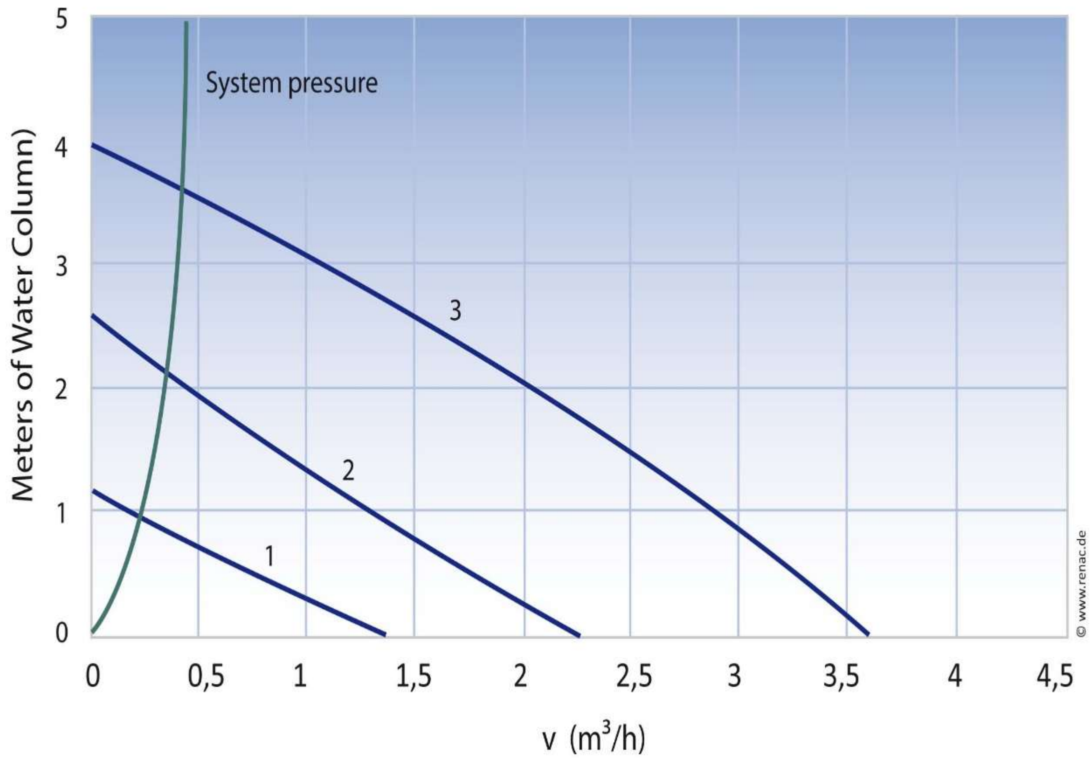


Primary circuit components:

- Pump
- Expansion tank
- Safety valve or pressure relief valve
- Regulation
- Sensor (thermometer), flow meter
- Piping
- Purge valve or Air vent
- Non-return valve
- Coolant (antifreeze)

FORCED CIRCULTION SWH
System components

Pump



Pump sizing based on system flow and pressure losses

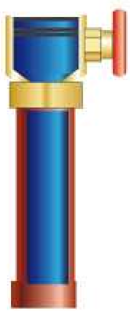
FORCED CIRCULTION SWH
Security system components

Safety valve

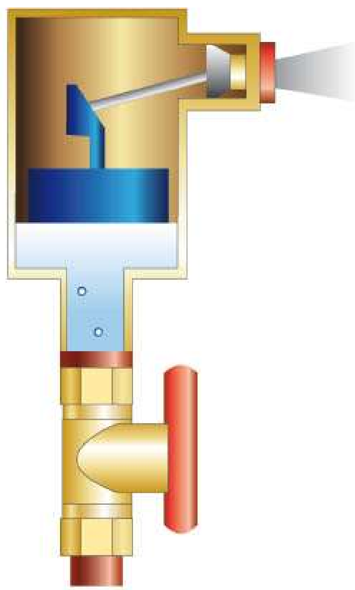
A valve that opens automatically to relieve excessive pressure more than 6 Bars (in general)

FORCED CIRCULTION SWH
Security system components

Purge valve or Air vent

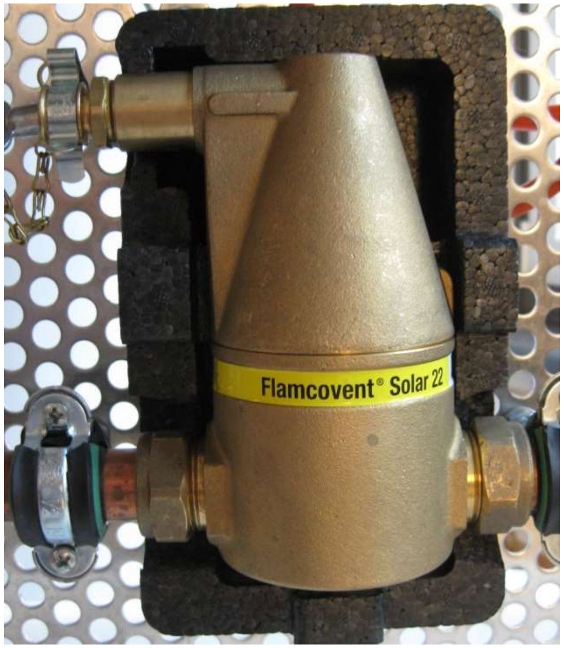


Manual
Purge Valve



Automatic
Purge Valve

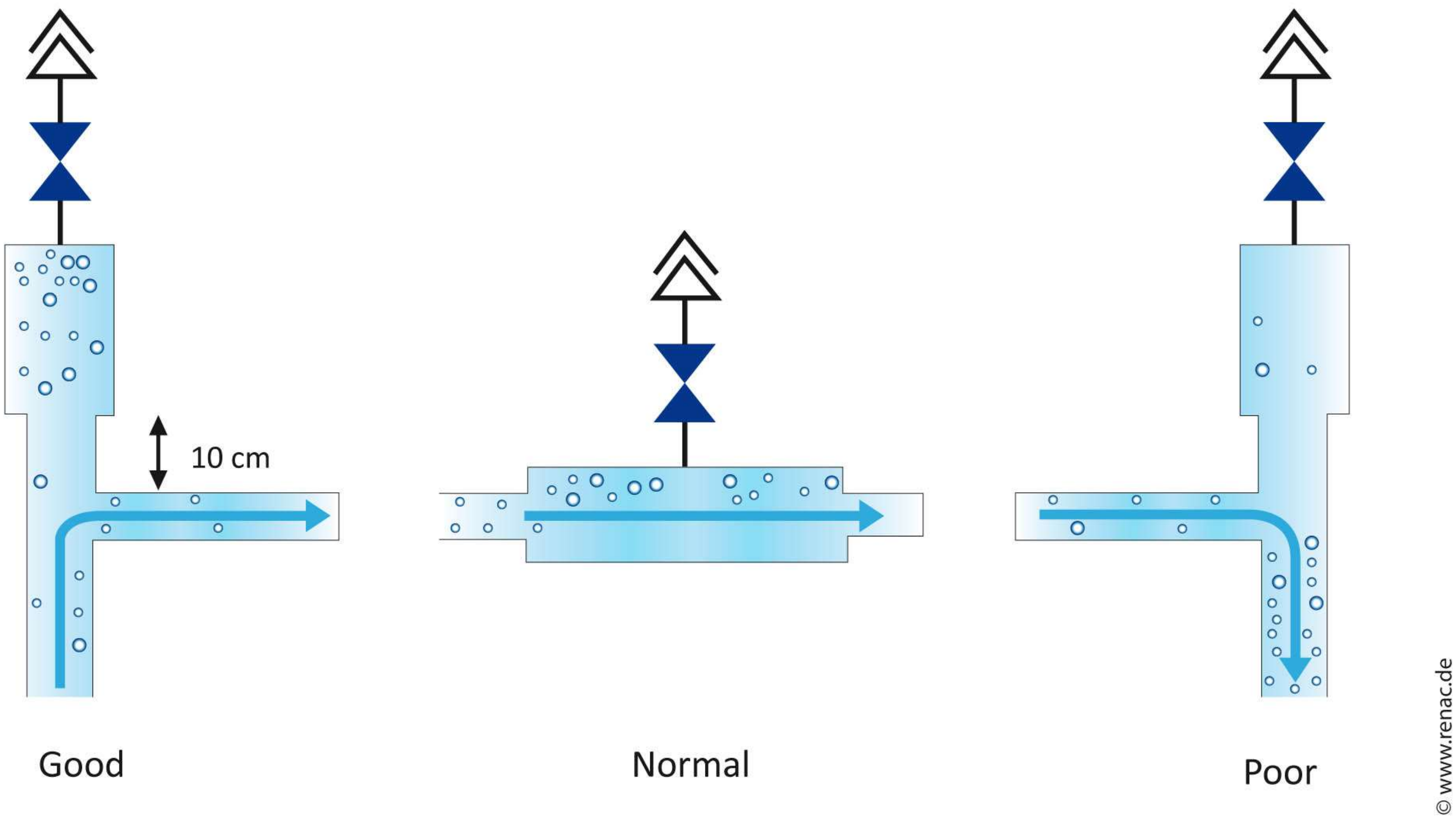
© www.renac.de



a valve that opens to purge or release air from the circulation loop

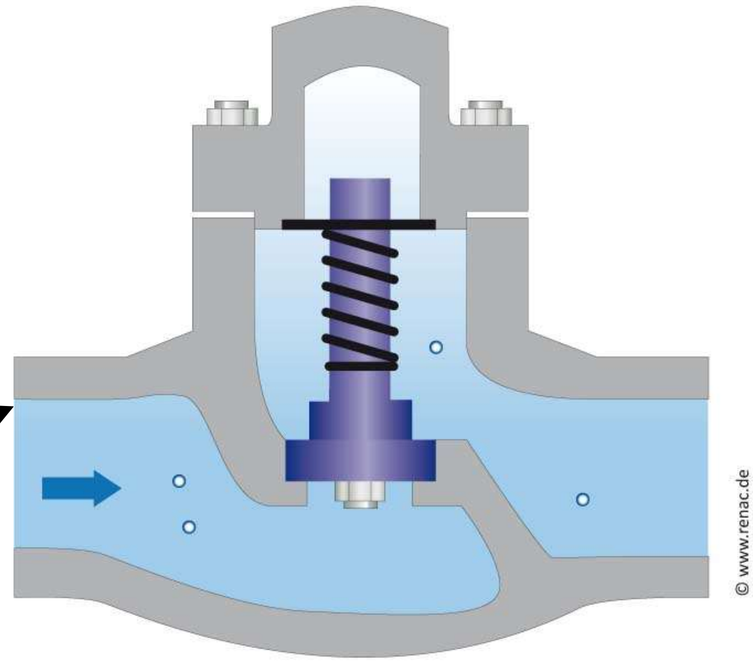
FORCED CIRCULTION SWH
Security system components

Purge valve position



FORCED CIRCULTION SWH
Security system components

Non return valve



- Used to prevent liquid from going in the wrong direction
- Prevents return flow (overnight)

Ex: Connection of the system / house to the sanitary water network, to avoid contamination of the supply network
Ex: to force the flow in desired direction

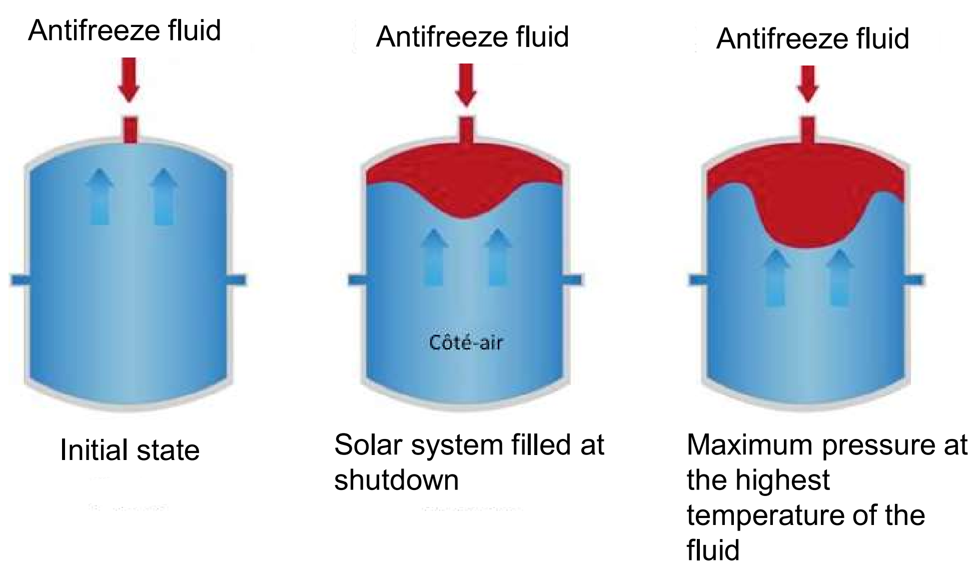
FORCED CIRCULTION SWH
Security system components

Expansion Tank

- To prevent loss of heat transfer fluid from the system via safety valve
- To allow the system to operate with the same safety In a stagnant state
- To protect the system components against the effects of high temperatures and pressures, as well as pressure and condensation shocks.

FORCED CIRCULTION SWH
Security system components

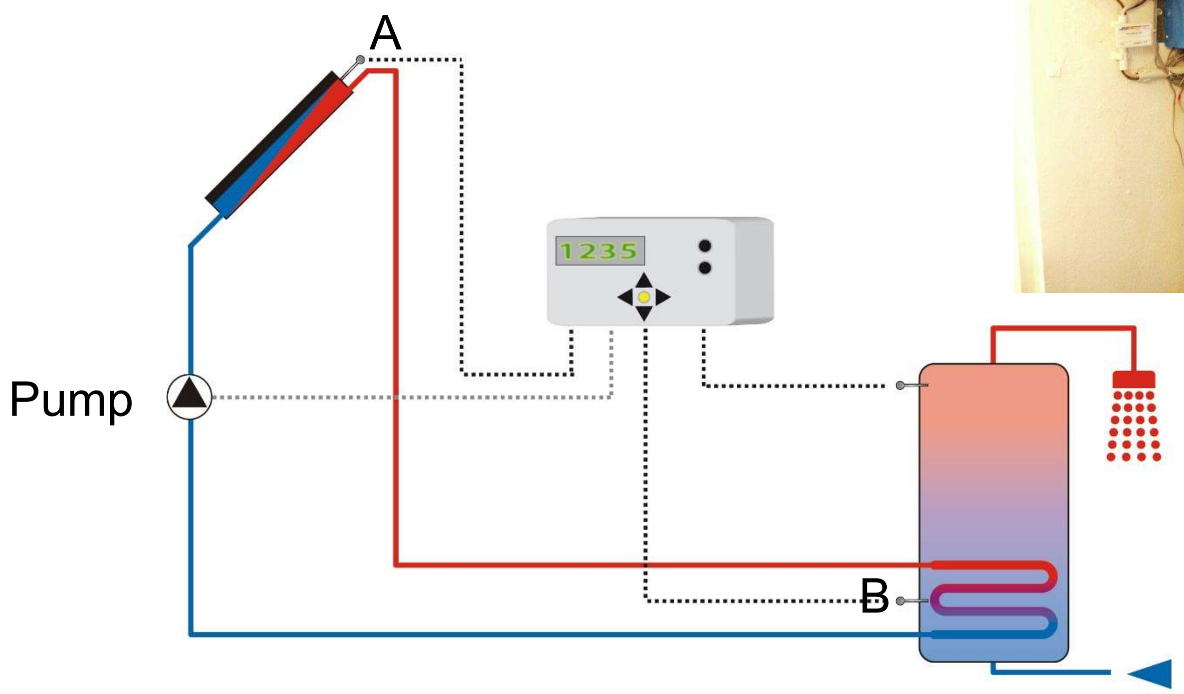
Expansion Tank operation



- The expansion tank compensates the fluid expansions and contractions
- The gas (air or nitrogen) and fluid   are separated by a rubber membrane
- The rubber membrane can only withstand temperatures up to around 90 ° C

FORCED CIRCULTION SWH
Security system components

Regulation operation

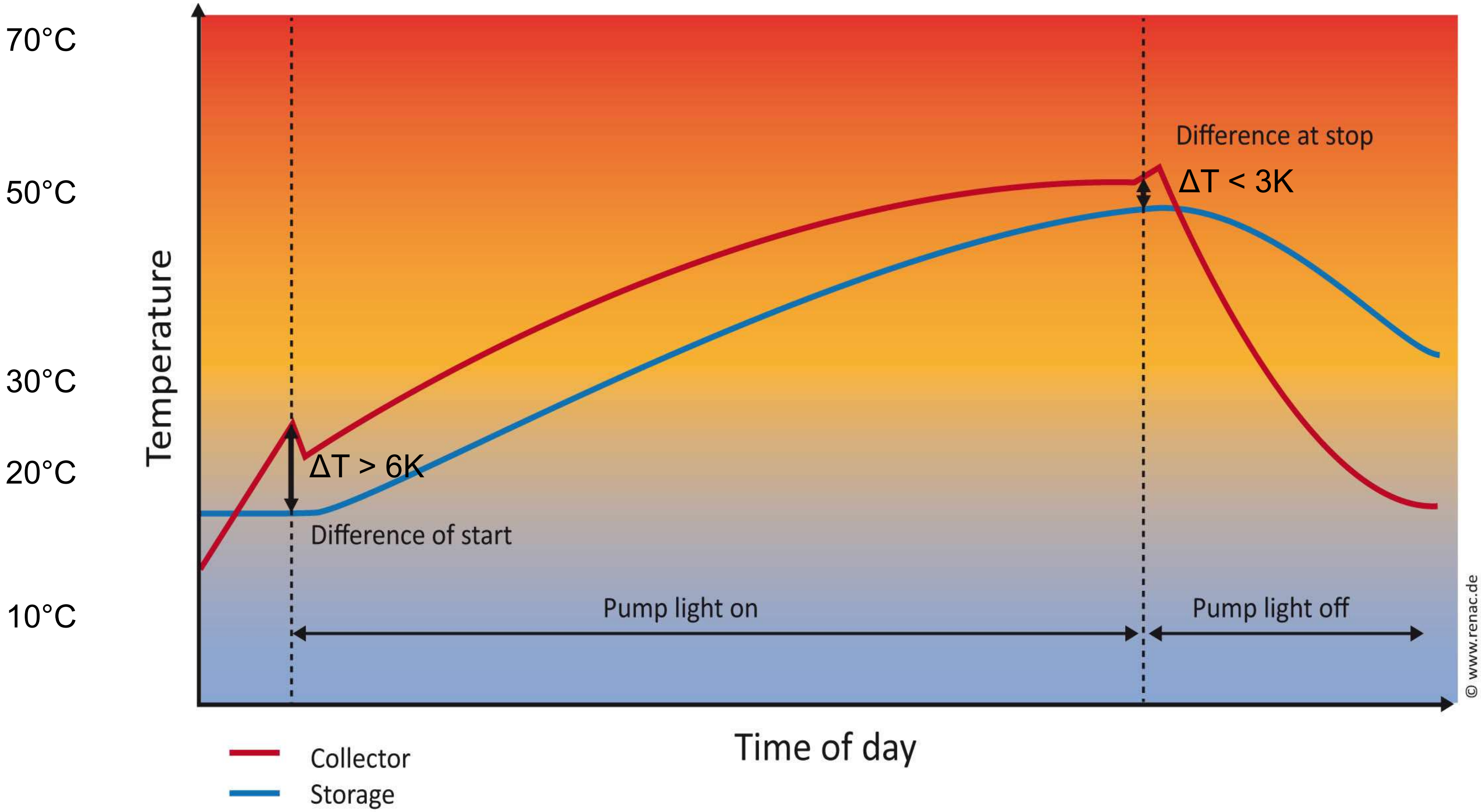


If temperature A > B + 6 K → pump light on
If temperature A < B + 3 K → pump light off

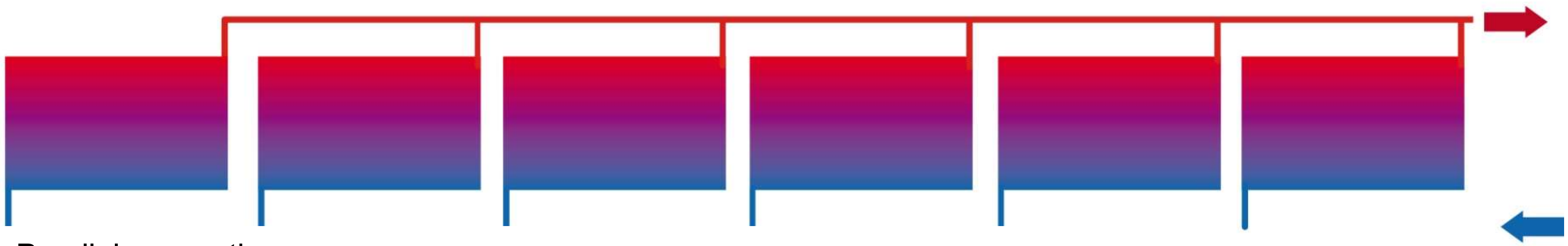
K: Kelvin

FORCED CIRCULTION SWH
Security system components

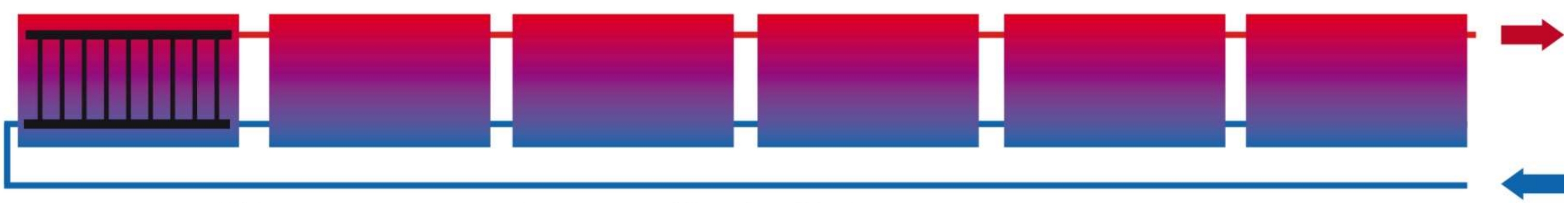
Regulation operation



FORCED CIRCULTION SWH
Connection type



Parallel connection



Parallel connection with Tickelman loop “ balanced flow”

Serie connection

FORCED CIRCULTION SWH
Flow and Pressure losses

- **Serie connection case** :

Total Flow $Q_{total} = Q_{collector}$

Total Pressure losses $\Delta P_{total} = \Delta P_{coll\ 1} + \Delta P_{coll\ 2} + \Delta P_{coll\ 3} + \ldots.\Delta P_{coll\ n}$

- **Parallel connection case :**

Total Flow $Q_{total} = Q_{coll\ 1} + Q_{coll\ 2} + Q_{coll\ 3} + \ldots.Q_{coll\ n}$

Total Pressure losses $\Delta P_{total} = \Delta P_{collector}$

Description	Specific flow (l/h m²)	Temperature rise (°C)
Low flow	12-15	34-43
Medium flow	15-30	17-34
High flow	>30	<17

FORCED CIRCULTION SWH
Flow and Pressure losses

Exercice 1

A collector field consists of 25 collectors with an active area of 2m2 per collector. Calculate the total flow of the system in a ‘low-flow’ system in which the specific flow = 15l / h m2

Allocated time
15 min

FORCED CIRCULTION SWH
Flow and Pressure losses

Exercice 1 : Solution

$$q_{total} = q_{spec} \times \text{no. de capteurs} \times A_{active}$$

$$q_{total} = 15 L / hm^2 \times 25 \text{ capteurs} \times 2 m^2 = 750 L / h$$

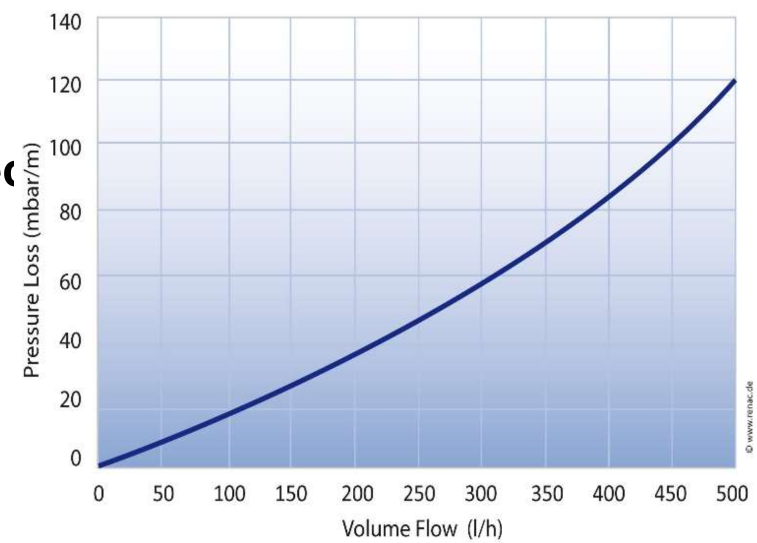
FORCED CIRCULTION SWH

Flow and Pressure losses

Exercice 2

Allocated time 30 min

A collector field is made of 6 collectors each having an active area of 2.5 m2. The minimum flow rate that each collector have to receive is 50l / h. Find below the pressure drop curve of the collector:



a) What are the pressure losses if the collec are connected in parallel and the total flow is 300l / h?

b) What is the specific flow rate (in l / h m2) for a row of collectors?

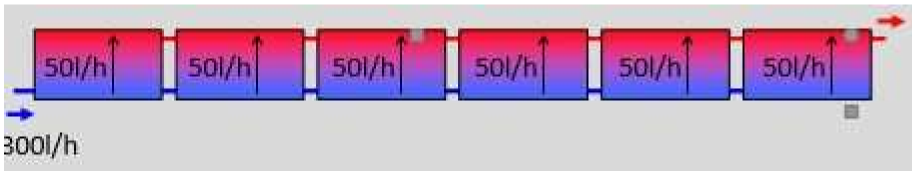
c) What are the pressure drops if the collectors are connected in series and the total flow is 225 L / h?

d) What is the specific flow rate (in l / h m2) for a row of collectors

FORCED CIRCULTION SWH
Flow and Pressure losses

Exercice 2 : Solution

a)

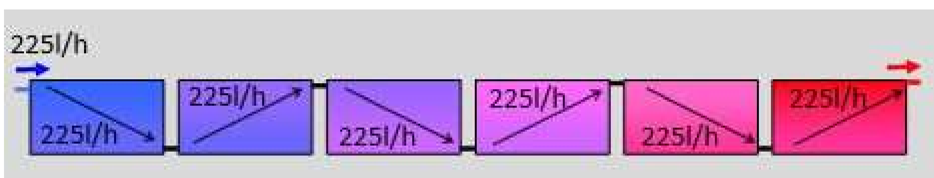


According to the graph , the pressure drops per collector at 50l / h = 10mbar
Since the collectors are connected in parallel, the total pressure drop is also 10mbar.

b)

$$\text{specificflow} = \frac{300\text{L/h}}{15\text{m}^2} = 20L/hm^2$$

c)



According to the graph , the pressure drops per collector at 225l / h = 43mbar
Since the collectors are connected in series, the total pressure drop is 43mbar x6 = 258 mbar

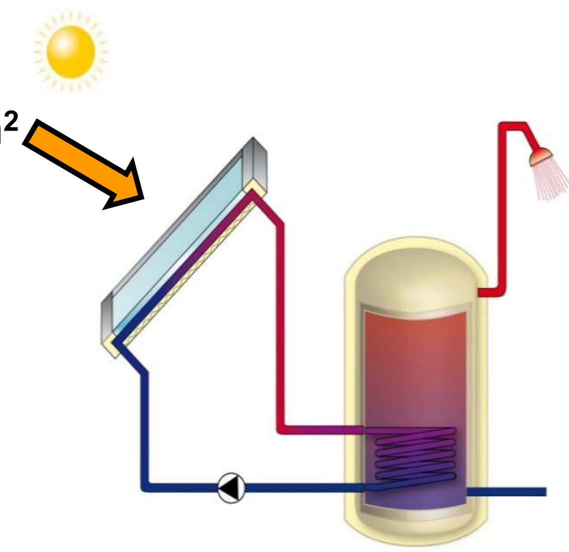
d)

$$\text{débit spécifique} = \frac{225\text{L/h}}{15\text{m}^2} = 15L/hm^2$$

FORCED CIRCULTION SWH
Temperature rise at collector field

$$\Delta T = \frac{P_{spec}}{q_{spec} \times \rho \times C}$$

P_{max} = 1000W/m²



with :

- ΔT = Temperature rise at collector field, in K or °C
- P_{spec} = Specific power in W/m2
- q_{spec} = Specific flow, in $m^3/(s.m2)$
- ρ = Water density, 1000 kg/m^3
- C = : Heat capacity of water, 4200 J/kgK

FORCED CIRCULTION SWH
Temperature rise at collector field

Exercice 3

$$\Delta T = \frac{P_{spec}}{q_{spec} \times \rho \times C}$$

Allocated time 15 min

Consider that the solar irradiance is 800W / m2 and the efficiency of the collector is 55%.

The density of water is 1000kg / m3 and that its specific heat capacity is 4200 J / kgK.

a) Calculate the temperature increase across the collector field in a 'low-flow'

system in which the specific flow = 15l / h m2

b) Calculate the temperature increase across the collector field in a 'high-flow' system in which the specific flow = 40l / h m2

FORCED CIRCULTION SWH
Temperature rise at collector field

Exercice 1 : solution

a)

$$\Delta T = \frac{P_{capteur}}{q \times \rho \times C}$$

$$\Delta T = \frac{800W/m^2 \times 0.55}{\left(\frac{15}{1000 \times 3600}\right) m^3/s \times 1000kg/m^3 \times 4200J/kgK} = 25K$$

b)

$$\Delta T = \frac{800W/m^2 \times 0.55}{\left(\frac{40}{1000 \times 3600}\right) m^3/s \times 1000kg/m^3 \times 4200J/kgK} = 9.24K$$

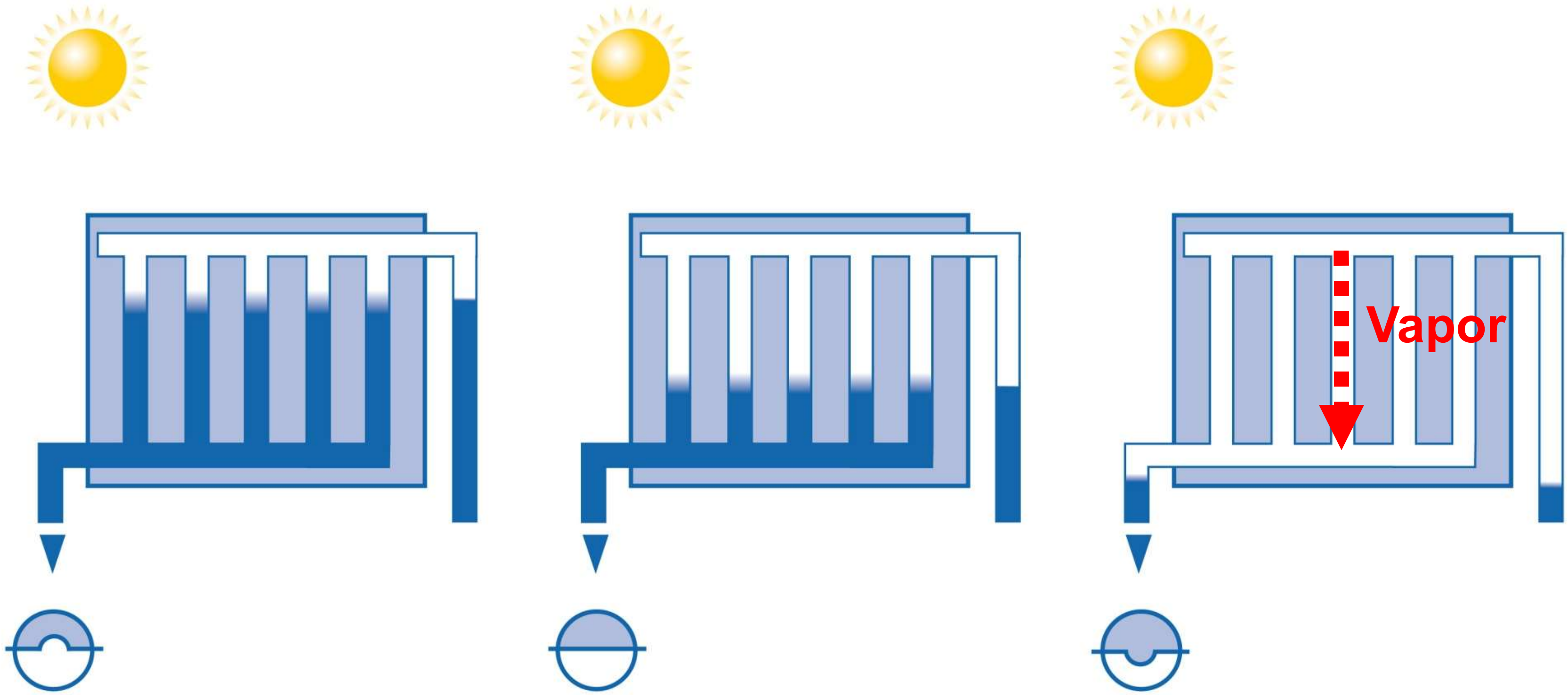
FORCED CIRCULTION SWH
Stagnation

Situation where hot water is not discharged when in the same time there are high and continuous irradiation levels incident on the collectors

CAUSES :

- ❑ No hot water requirements
- ❑ Storage tank has reached its maximum temperature
- ❑ Pump is broken
- ❑ Blackout
- ❑ Failure of regulation or collectors
- ❑ No flow
- ❑ No fluid

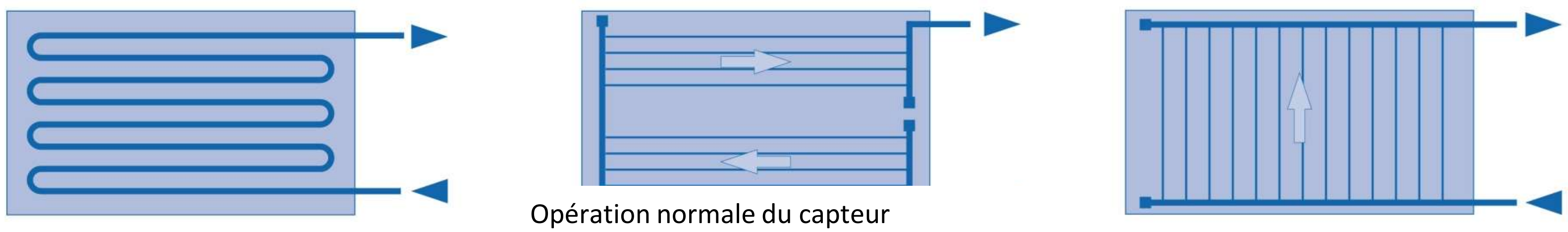
FORCED CIRCULTION SWH
Stagnation



At the stagnation case, Vapor formation in collector tube

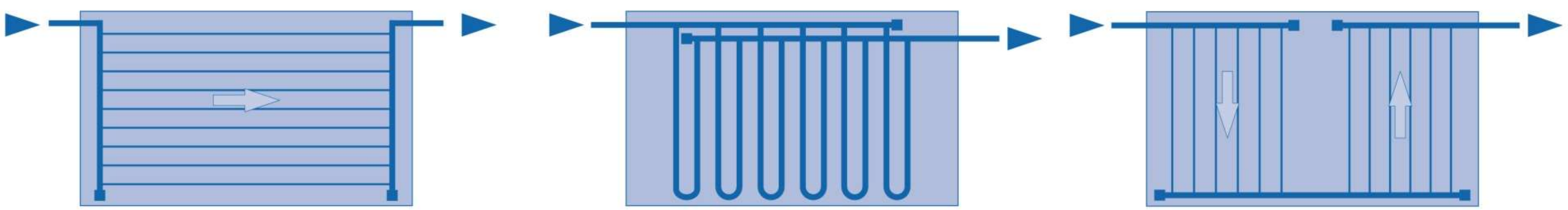
FORCED CIRCULTION SWH
Stagnation behavior

- Steam or vapor easily leaves the collector, ensuring low pressure



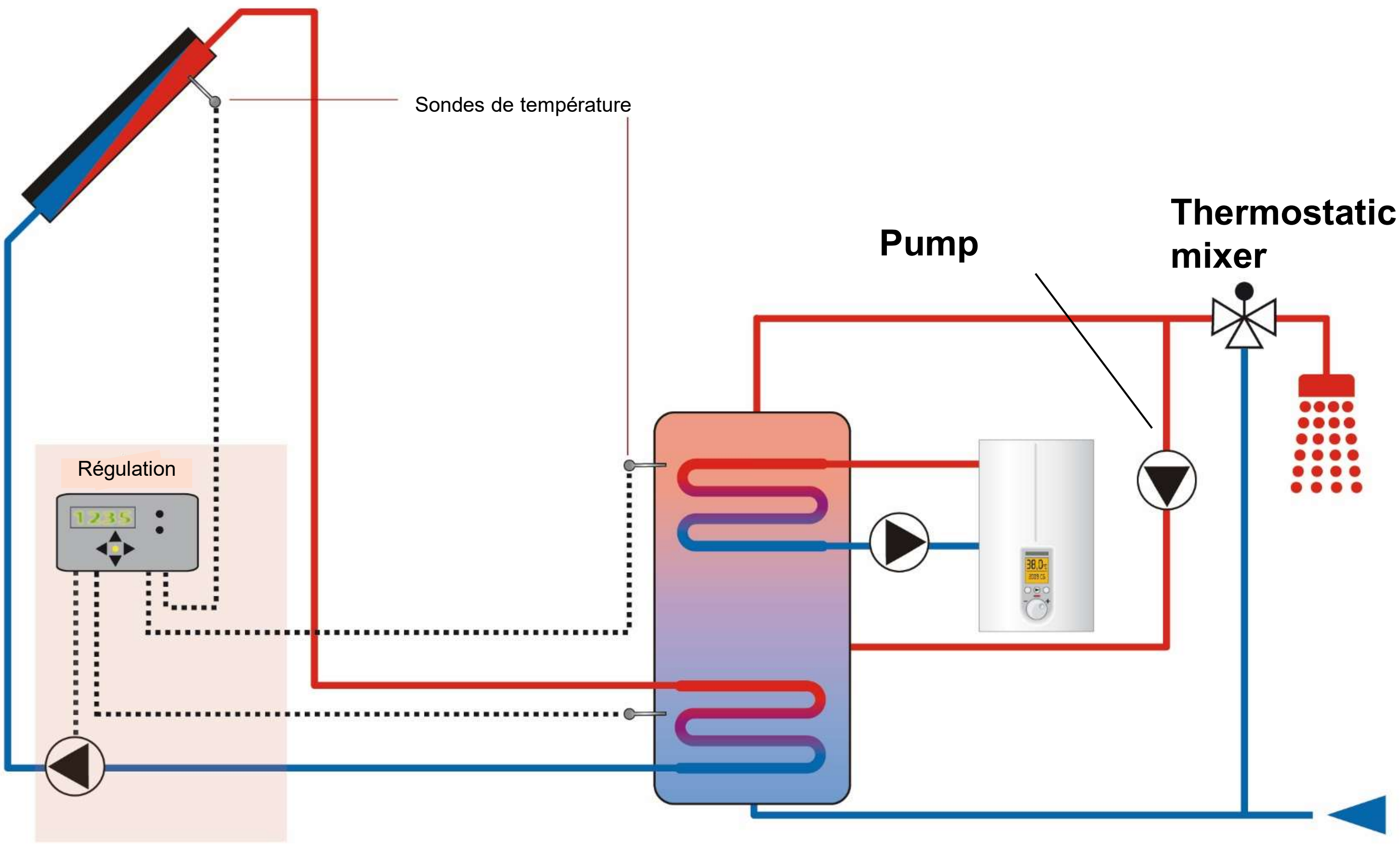
Opération normale du capteur

- Steam or vapor leaves the collector with difficulty, which has the effect of trapping liquid under high pressure

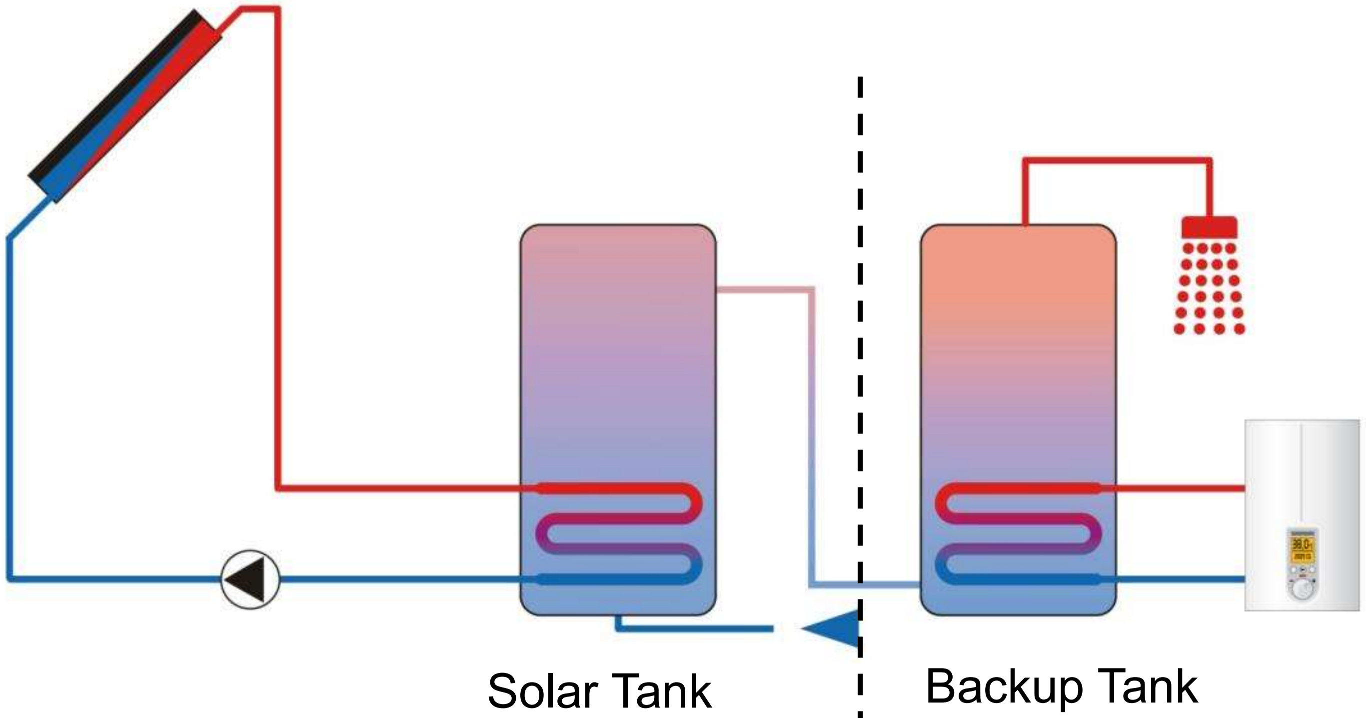


FORCED CIRCULTION SWH

Classic system with backup

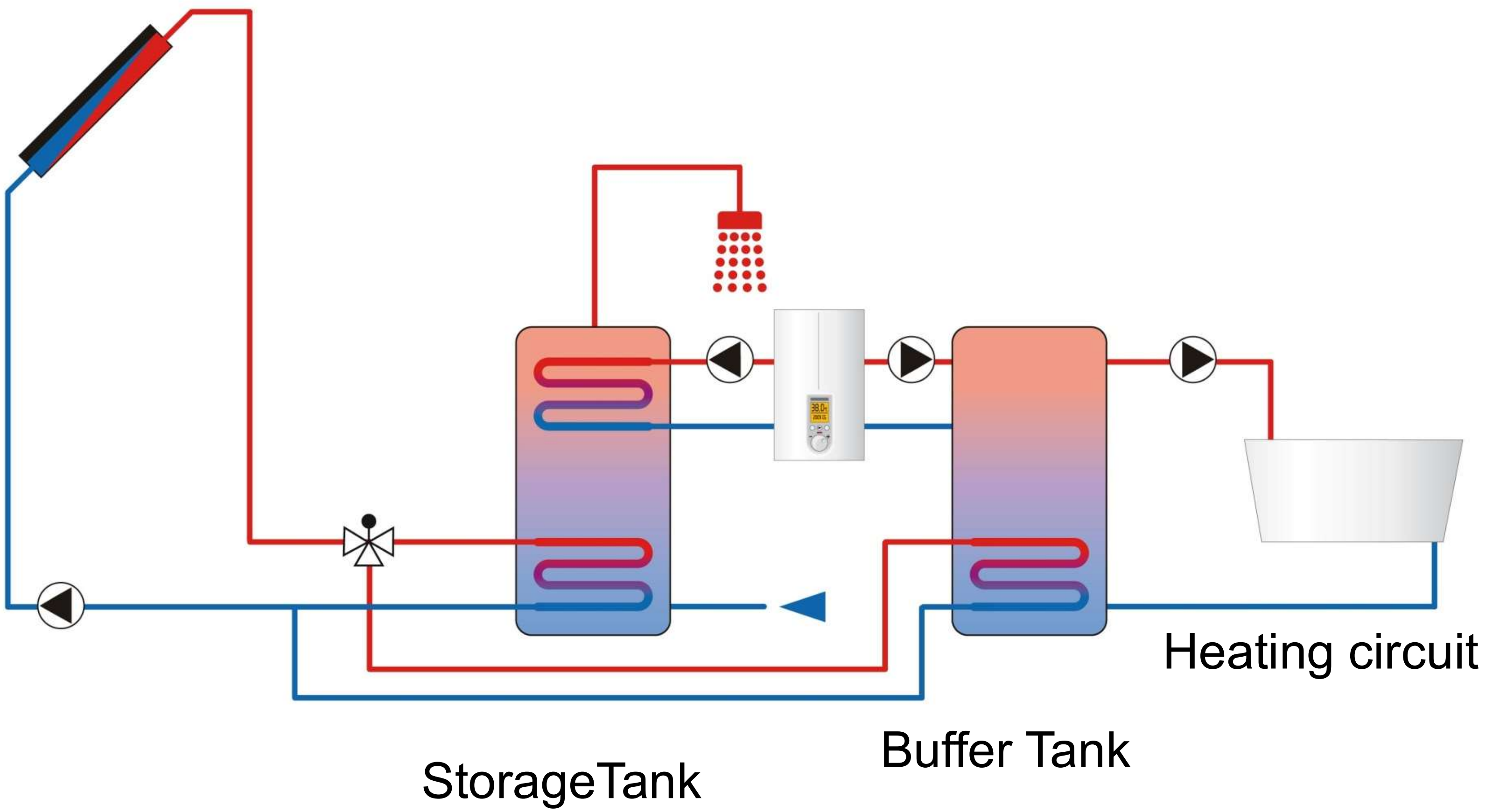


FORCED CIRCULTION SWH
System in series

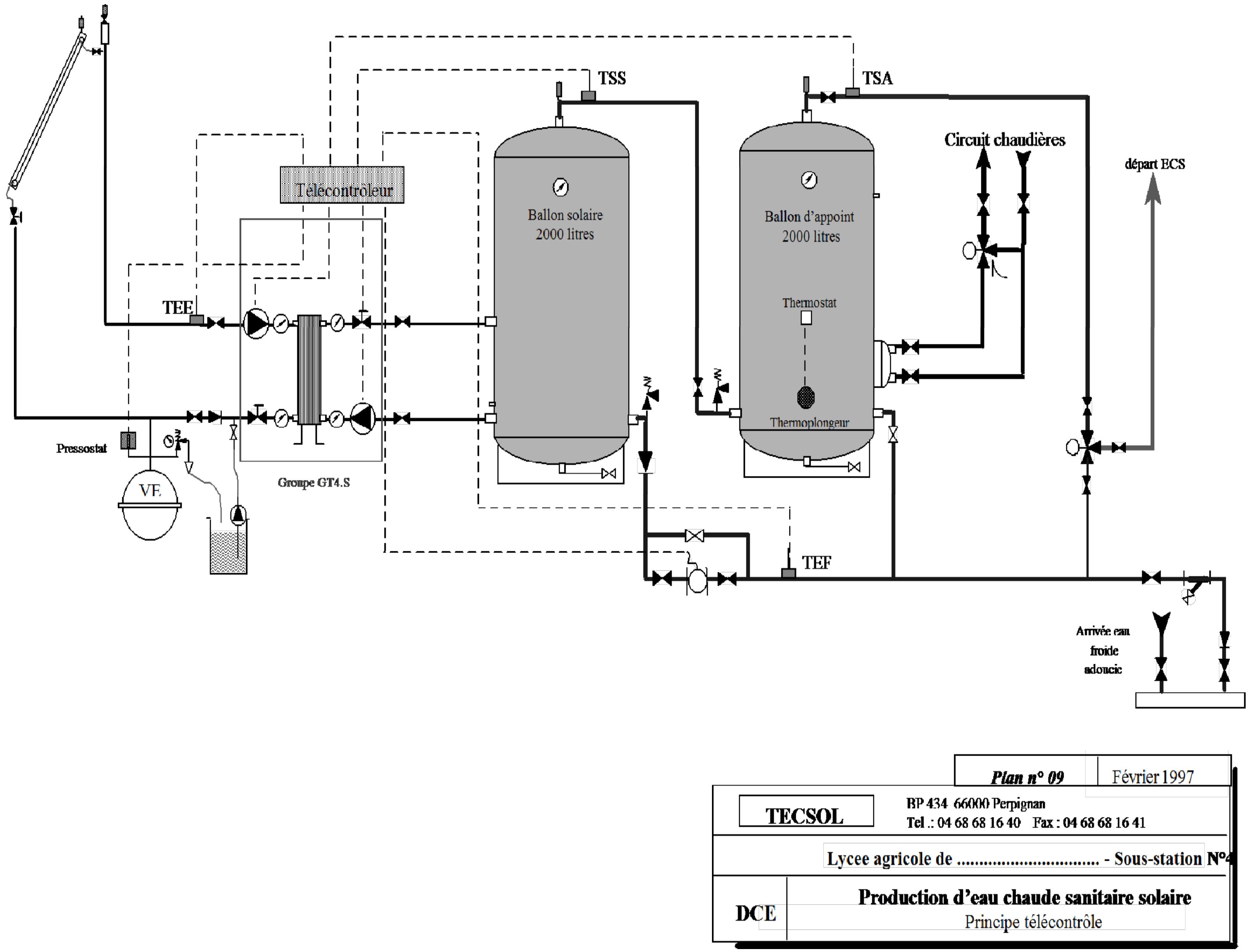


Connect the first tank outlet pipe to the second tank inlet pipe

FORCED CIRCULTION SWH
Mixing system : Heating + DHW



FORCED CIRCULTION SWH
Simple example



FORCED CIRCULTION SWH
Commissioning

a. Rinsing the primary circuit
b. Filling the primary circuit
c. Parameter setting
d. Test the system
e. Purging air from the secondary circuit

FORCED CIRCULTION SWH
Commissioning

Rinsing the primary circuit (solar circuit between collectors and storage tank)

Rinsing the primary circuit is very important specially if pipes have been connected by **welding** or **soldering**.

Dirt ore tinder could be left in the pipes and can cause **malfunction** of the system.

Other ways thin pipes in the collectors heat exchangers pumps or flow controls can be **blocked**.

Rinsing the system with water is not possible for the collector field during **high radiation** or **temperatures below zero**.

If the system is not being filled afterwards make sure there is **no liquid left** in the collector field.

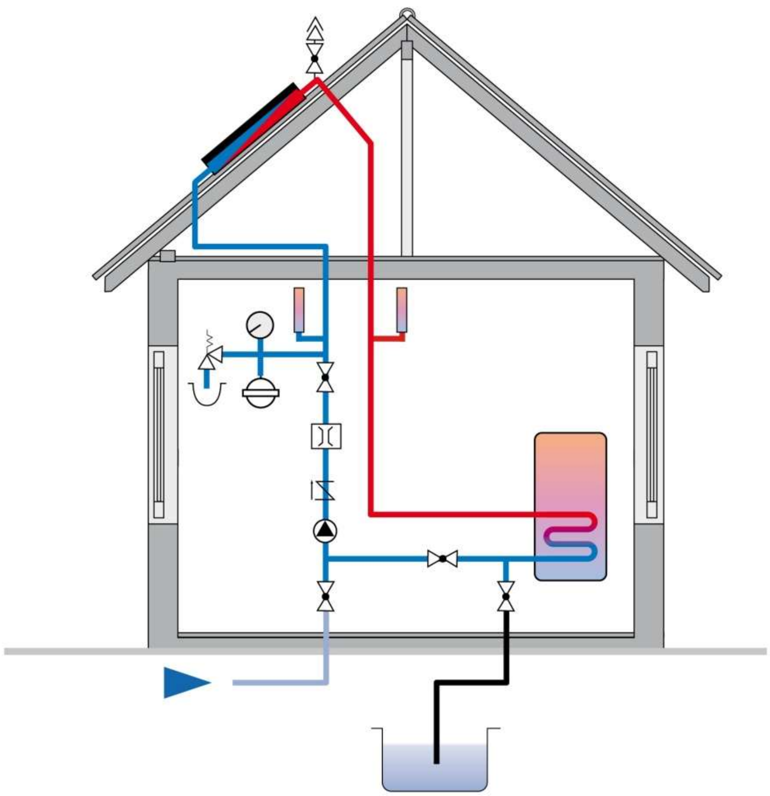
FORCED CIRCULTION SWH
Commissioning

Filling the primary circuit

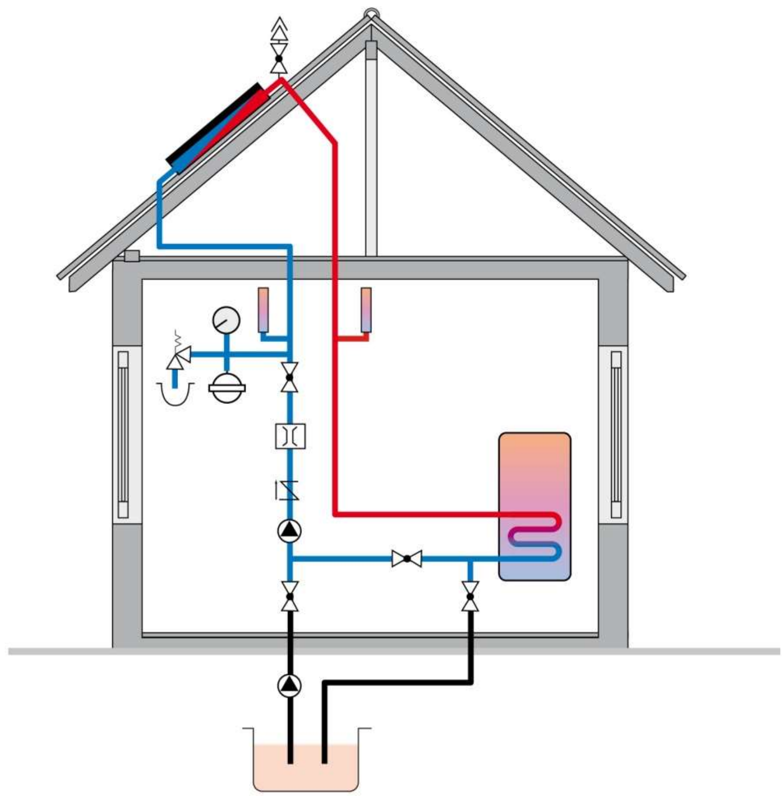
- Adjust the pressure on the air side of the expansion tank
- Fill the system slowly when draining from the top
- Quickly fill the system when draining from the bottom
- Use a pre-diluted solution of antifreeze fluid (if necessary)
- Set the pressure to a preset value (equal to the height of the installation above the expansion tank, increased by 0.6 bar, with a minimum of 1 bar)
- Maintain the circulation for a few hours or a day
- Monitor system pressure repeatedly
- Close the automatic air vents at the end of the air purge

FORCED CIRCULTION SWH
Commissioning

Filling / Rising the primary circuit



Rinsing

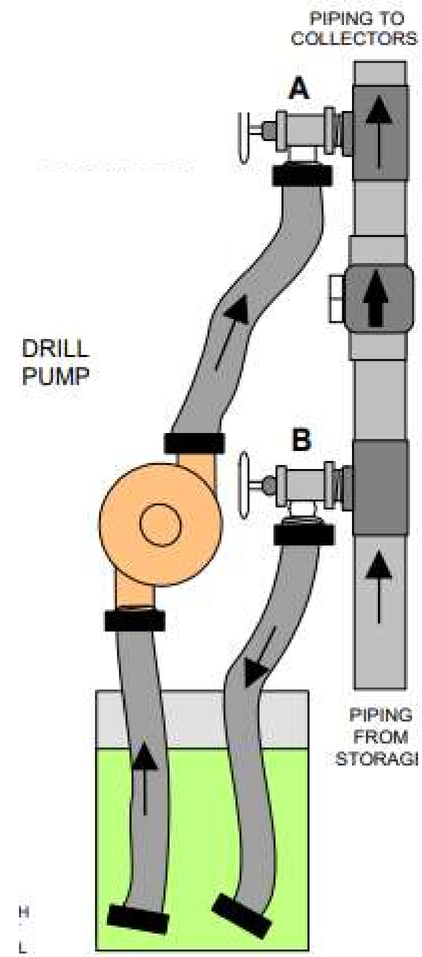


Filling

FORCED CIRCULTION SWH
Commissioning

Practical Rinsing Procedure

The collector loop should be purged with water prior to filling. This can be done with a garden hose hooked to valve A with valve B open and draining the purged water. This will get all solder flux and other impurities out of the system.

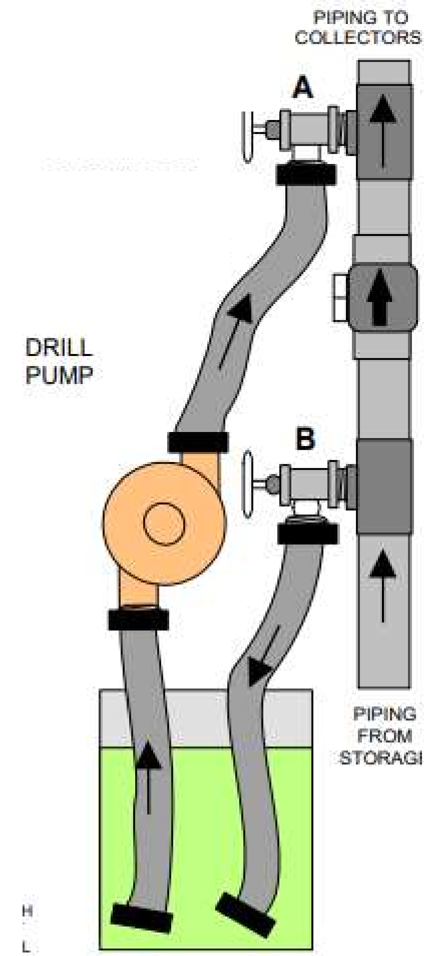


FORCED CIRCULTION SWH
Commissioning

Practical Filling Procedure

After the system is purged it should be drained:

1. Fill the bucket with a solution of propylene glycol and water.
2. Open both valve A and B if they are not already open.
3. Start the pump and pump the solution into the system through valve A. You should see air bubbles coming back into the bucket through the hose connected to valve B.
4. Add more solution to the bucket if necessary always making sure to add equal parts of propylene glycol and water. When the system is full, the liquid will flow into the bucket.
5. Keep pumping for a few minutes until the liquid coming from valve B no longer has any air bubbles in it.
6. Keep the hoses connected and while still pumping let any air out of the system at the top point in the system - either the pressure relief valve (safety valve) or the air vent.
7. When all of the air is out of the system close valve B and watch your pressure gauge.
8. Pump the system up to between 1 and 2 bars or the maximum pressure of your pump.
9. Close valve A and disconnect the hoses slowly to catch any spills. The system is ready to run



FORCED CIRCULTION SWH
Commissioning
Parameters setting

- Set all pumps to a given speed or power settings
- Set the volume flow to a value given in all circuits
- Adjust all pressure settings
- Set all parameters for system regulation
- Calibrate the measurement system
- Test / adjust pressure safety valves
- Adjust the thermostatic mixer
- Document all parameters and settings

FORCED CIRCULTION SWH
Commissioning

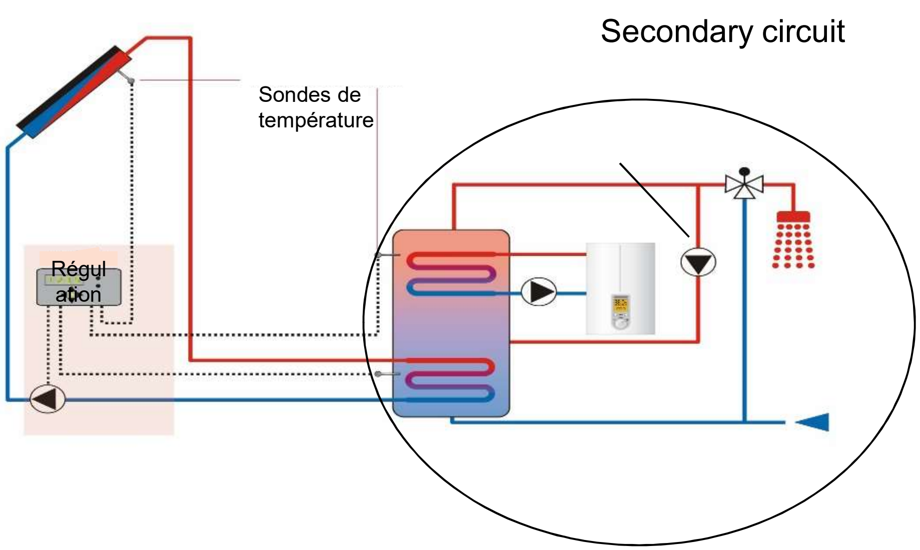
System Test

- Check the temperature indicated on all thermometers
- Test all control operations
- Test motorized pumps and valves
- Check the temperature difference at the heat exchangers
- Check for leaks
- Test all fuses, switches and electrical outlets
- Test the warning lights and audible alarms
- Check the antifreeze fluid

FORCED CIRCULTION SWH
Commissioning

Purging air from the secondary circuit (between storage tank and water tap house)

- ❑ Open at least one hot water tap in the house
- ❑ Leave the hot water tap open until the air bubbles have completely disappeared, then close and allow the tank to build up pressure
- ❑ Check any leakage on the pipelir



SOLAR Heating
for Industrial Process
Together Toward Efficient Production

SWH:
Practical part with forced systems

Training of SWH installer & maintainer

Ministry of Trade & Industry
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DAY3 – PRACTICAL PART
Forced circulation installation system

Objective:

- ✓ Practice the knowledge of the design/morning
- ✓ Improve skills of installers in forced systems
- ✓ Get trained on the installation of forced system

Duration

- ✓ 6:30 hours with one coffee break and one lunch break
- ✓ From 10:30 to 17:00
- ✓ Close phones
- ✓ Don’t speak to each other

DAY3 – PRACTICAL PART
Forced circulation installation system

- Collector installation
  - Individual collector
  - Series collectors
- Tank installation
  - Horizontal position
  - Water pressure
  - Circulator
- Heat exchanger
- Insulation
- Accessories (Pump station, expansion tank, safety valves devices)

DAY3 – PRACTICAL PART
Forced circulation installation system

- Connection between different components
  - Cold water connection
  - Hot water connection
  - Exchanger connection
  - Circulator connection

- Safety equipment
  - Individual
  - Collective

- Tools
  - Individual tools
  - Collective tools

Please add pictures for the steps
Yahia El-Masry, 04-Aug-20

YE1

DAY3 – PRACTICAL PART
Forced circulation installation system

- ❑ Measurement devices
  - - temperature sensors
  - - pressure gauge
  - - Flow rate gauge
- ❑ Verification
- ❑ Manual of operation
- ❑ Commissioning the installation
- ❑ Advise for operating
- ❑ Best practices for maintenance

DAY2 – PRACTICAL PART
Thermosiphon system installation

Organization:

- ✓ Work in small groups
- ✓ Identify SWH components
- ✓ Identify necessary tools
- ✓ Follow the trainer instructions
- ✓ Follow the SWH manual of installation
- ✓ Respect safety requirements
- ✓ Have the individual safety equipment's

SOLAR Heating
for Industrial Process
Together Toward Efficient Production

SWH: Practical part for maintenance & repair

Training of SWH installer & maintainer

Ministry of Trade & Industry
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DAY4 – PRACTICAL PART
Maintenance and repair

Objective:

- ✓ Practice the knowledge of SWH manual
- ✓ Improve skills of installers on M&R
- ✓ Get trained on Maintenance and repair

Duration

- ✓ 3:30 hours with one coffee break and one lunch break
- ✓ From 9:00 to 12:30
- ✓ Close phones
- ✓ Don’t speak to each other

DAY4 – PRACTICAL PART
Maintenance and breakdowns repair

- Preventive maintenance (Refer to Preventive checklist)
  - Guarantee
  - List of preventive maintenance
  - Operation way
  - Manual of maintenance provided by suppliers

- Identification of faults (Refer to Practical guide : Diagnosis method)
  - Check list of trouble shootings
  - Diagnosis
  - Component identification
  - Costing

- Curative maintenance (Refer to troubleshooting checklist)
  - Correction
  - Verification
  - Handout

SOLAR Heating
for Industrial Process
Together Toward Efficient Production

SWH: Maintenance and repair forced systems

Training of SWH installer & maintainer

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DAY4 – MAINTENANCE & REPAIR
SWH forced systems

Objective:

- ✓ Increase knowledge on maintenance of forced SWH
    - Preventive
    - Curative
- ✓ Improve skills of installers on M&R for FSWH
- ✓ Get trained on maintenance and repair of FSWH

Duration

- ✓ 1:30 hours with one coffee break
- ✓ From 13:30 to 15:00
- ✓ Close phones
- ✓ Don’t speak to each other

Maintenance & repair
Check list for preventive maintenance

In the event of maintenance or repair, cut off the cold water supply and electricity before taking any action

Component inspection	Action(s)
Flat plate Collector/ evacuated tube glazing and seals	Look for cracks in the collector/ evacuated tube glazing, and check to see if seals are in good condition
Plumbing, pipework, and wiring connections	Look for fluid leaks at pipe connections. Check pipe connections and seals. pipes should be sealed with a mastic compound. All wiring connections should be tight
Piping and wiring insulation	Look for damage or degradation of insulation covering pipes and wiring
Roof penetration	Flashing and sealant around roof penetrations should be in good condition.
Support structures	Check all nuts and bolts attaching the collectors to any support structures for tightness Check the metal condition (anti corrosion paint if necessary)
Safety valves	Make sure the valve is not stuck open or closed

Maintenance & repair
Check list for preventive maintenance

Component inspection	Action(s)
Pump	Verify that distribution pump is operating. If you can't hear a pump operating, then either the controller has malfunctioned or the pump has broken
Regulation	Check the regulation is operational Data displayed by the regulation is plausible Temperatures displayed by the regulation are plausible (periodically measure the resistance of temperature sensors)
Antifreeze fluid	Check and / or change the antifreeze fluid in the closed circuit. The frequency of this operation is often reported in the supplier's manual
Storage tank	Regular drain and clean the Tank storage to prevent the risk of bacterial proliferation Check for cracks, leaks, rust, or other signs of corrosion
Magnesium anode	Check the anode state. When the anode reaches a level of wear, its diameter becomes very small, which causes leaks at the clamping nut. This problem is accelerated by the non earthing of the anode (quite frequent case)
Back up (electrical case)	Check any damage to the sleeves, electrical cables Check that the electrical connections and grounding are in good condition. Check the thermostat setting Check the condition of the electric resistance (scale deposit)

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
No hot water	Auxiliary Heater (electric)	No power to auxiliary back-up heating element	Check high temperature protection and push reset button above thermostat. (Use caution when dealing with electricity.)
	Auxiliary heater (gas)	Failure to ignite	Check pilot light mechanism
		Safety switch malfunctioning	Check and replace
		Defective automatic pilot valve	Check and replace
		Pilot valve defective	Replace
		Loose thermocouple connection	Tighten
		Defective thermocouple	Replace
		Improper pilot gas adjustment	Adjust
	Auxiliary heater thermostat	Thermostat defective	Replace
	Mixing valve	Improper adjustment	Check water temperature at house faucet and adjust valve setting
		Valve defective	Replace or remove from system plumbing
	Distribution piping	Leak (under slab or in walls)	Locate leak and correct

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Not enough hot water	Auxiliary heater	Undersized for hot water demand load	Replace
		Storage tank losses	Insulate tank
		Thermostat set too low	Increase set point temperature
		Element failure	Replace element
		Thermostat failure	Replace thermostat
		Lower element disconnected in conventional rank system	Reconnect element and set thermostat to low temperature
	Non return valve	Heat loss due to defective or improperly installed check valve	Inspect valve and repair or replace

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Not enough hot water	Collector(s)	Absorber coating degradation	Recoat or replace absorber (Contact manufacturer)
		Area undersized	Increase collector area (See FSEC Sizing Guide)
		Excessive condensation	Inspect and repair glazing seal, pipe gaskets and weep holes and vents at bottom
		Glazing dirty	Clean as required
		Leaks	Repair
		Orientation	Check orientation. Face collector " south
		Outgassing inside collector glazing	Clean surface and contact manufacturer
		Plastic glazing deteriorating	Replace
		Reduction of glazing transmission	Replace glazing
		Shaded by tree(s) or building(s)	Remove obstacle and shading or relocate collectors(s)
		Improper tilt	Check tilt for geographic area. Set " 15° of latitude
		Improperly plumbed	Compare with system schematic in installation Manual

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Not enough hot water	Differential controller	Improper operation (cycling, late turn on)	Check sensor placement and insulation from ambient conditions
		Faulty sensors or controller	Conduct resistance measurement or check by placing sensors against hot and cold-water glasses and watching pump function. Replace defective units.
		Improper wiring or loose connections	Compare with system schematic. Check for proper connections. Seal all splices against moisture.
		Shorted sensor wiring	Check wiring for breaks, metal contact, water exposure and corrosion.
	Heat exchanger	Sized too small	Replace with properly sized heat exchanger. Insulate.
		Scaling, clogging	Back flush, clean
	Isolation valves	Closed	Open
	Mixing valve	Improperly adjusted	Reset temperature indicator
	Owner	High water usage	Check system size and discuss solar system and owner's lifestyle

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Not enough hot water	Piping	Clogged with corrosion or sediment	Replace excessively corroded components
		Insufficient insulation	Add insulation where required
		High heat losses	Check insulation for splits, deterioration, absence
		Nighttime thermosiphoning	Check for pump operation at night.
		Improperly plumed	Compare with system schematic. Check flow direction.
		Isolation valves closed	Open valves
		Isolation valve failure after closing	Replace valve
		Flow blockage	Flush system. Check effluent for dirt/scaling.
		Low system pressure	Check pressure gauge. Refer to owner's manual for correct pressure.

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Not enough hot water	Pump	No power	Check breaker, pump, and controller. Repair or replace.
		Flow rate too high or too low	Adjust flow rate
		Defective	Check and replace
		No power	Check breaker, pump cord, controller fuse, if any. Replace if necessary.
		Faulty pump	Listen for irregular noises in pump operation. Feel collector feed and return pipes for temperature difference.
		Runs continuously	Check control system for breaks and shorts
		Improperly installed	Compare with system Schematic
	Storage tank	Too small	Install larger tank
		Storage losses	Insulate tank with insulation blanket
	Sensors	Improper wiring, cuts, or loose connections	Check and correct

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
No hot water in morning	Non return valve	Stuck open or does not seat	Replace non return valve
	Controller	Sensor wires reversed	Check wiring and reconnect
	Water heater circuit breaker	Water heater circuit breaker shutoff	Turn breaker back on
	Occupants	Excessive consumption	Discuss hot water usage. Check system size and auxiliary heater status.
Water too hot	Auxiliary heater	Thermostat set point too high	Reduce set point temperature
	High limit sensor	Improper calibration	Check, recalibrate and replace
	Occupants	No hot water use (vacation, etc.)	Run hot water to reduce tank temperature
	Mixing valve	Temperature set too high	Adjust
	Mixing valve	Valve failure	Replace valve
No water	Cold-water supply valve	Valve closed	Open valve

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump does not start	Differential controller	Controller switch in "off" position	Turn to "automatic" or normal operating position.
		Unplugged	Return power to controller
		On and/or off temperature differential set points too high	Reset according to specifications
		Loose contacts	Clean contacts and tighten connections or replace
		Defective components	Replace components or Controller
	Controller circuitry	Sensors connected to wrong terminal	Correct per manufacturer's recommendations
	Electrical power supply	On/off switch is "off"	Turn to "on"
		Blown fuse or breaker tripped on overload	Determine cause and replace fuse or reset breaker
		Defective	Check and replace, if required

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump does not start	Pump	Motor failure	Check brush holders and other mechanical components that may be loose, worn, dirty or corroded. Replace as appropriate and reasonable. Check for thermal overload.
		Pump motor runs when started by hand. Capacitor failure.	Replace capacitor
		No power	Check breaker, cord and Controller
		Stuck shaft or impeller	Replace
	Sensors	Defective sensor(s)	Replace
		Improper installation	Clean and reinstall properly
		Sensors out of calibration	Recalibrate or replace
	Sensor wiring	Defective sensor wiring	Repair or replace
		Open collector sensor wiring	Check wiring continuity. Repair or replace.
		Shorted tank sensor wiring	Check wiring for continuity. Repair or replace.

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump starts, but cycles continuously	Differential controller	On and off temperature differential set points are too close together	Reset according to specifications
		Faulty controller	Use controller test set to perform operation check. Repair or replace.
	Piping	Reversed connections to Collector	Reconnect properly
	Sensors	Improper location	Relocate sensors as per system design or manufacturer's requirements
		Not properly secured	Secure properly and insulate from air
		Faulty	Test sensors. Replace if necessary.
Pump cycles after dark	Sensor wiring	Interference from radio or garage door opener, etc.	Use shielded sensor wire
		Radio frequency interference from close proximity to antenna.	Use shielded sensor wire
	Non return valve	Does not seat	Replace

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump runs continuously	Controller	Off temperature differential set point too low	Reset according to specifications
		Lightning damage	Replace controller
		Controller in “on” position	Turn to “automatic” or normal run position
	Sensor(s)	Sensor(s) out of calibration	Recalibrate
		Defective sensor	Replace
		Improper installation	Reinstall
	Sensor wiring	Interference from radio/garage door opener, etc.	Shielded cable may be necessary
		Shorted collector sensor wiring	Check wiring for continuity. Check wiring connections for weather tightness. Repair or replace.
		Open tank sensor wiring	Check wiring for continuity. Check wiring connections for weather tightness. Repair or replace.

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump operates but no fluid flows from collector	Air vent	System air-locked. Air vents closed.	Disassemble and clean seat and seal. Replace if necessary.
		Improper location	Install at the highest point. Install at all high points if possible air trap locations exist. Install in true vertical position.
		Air vent cap tight	Loosen ¼ turn
	Non return valve	Installed improperly	Check flow arrow on valve to ensure direction is per system design
	Collector	Flow tubes clogged	Flush collector tubing
	Rinsing valve	Rinsing valve stuck in drain position	Clean cause of sticking. Check power to valve.
	Fluid	No fluid in direct system	Open cold-water supply valve
		Loss of fluid in indirect system	Locate leak and refill
		Loss of fluid in drain-back system	Cool system, locate leak, refill properly
	Isolation valves	Valves in closed position	Open valves
	Piping	Clogged or damaged piping	Unblock piping or repair damaged piping

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump operates but no fluid flows from collector	Pump	Broken impeller shaft	Replace shaft
		Impeller broken or separated from shaft	Replace impeller and/or shaft or replace pump
		Improperly installed	Install to ensure correct flow
		Not vented properly	Install in correct orientation
		Undersized	Check pump specifications. Change pump if required.
	Valves	Valves closed	Open valves
Pump cycles on and off after dark	Non return valve	Corroded or defective non return valve	Repair or replace
Pump runs after dark, but eventually shuts off	Sensors	Defective	Change sensor
		Improper location	Relocate
		Sensor not insulated	Insulate
No power to pump with switch on	Controller output relay	Weak or failed relay	Replace relay or controller

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Noisy pump	Air vents	Air trapped in system	Open automatic air vent
	Pump bearings	Dry or excessive wear	Lubricate or replace
	Pump impeller	Loose impeller	Tighten or replace impeller
	Pump location	Pump enclosed in small room (closet)	None
		Pump attached to wall – wall acts as amplifier	Relocate pump if noise is unacceptable
	Vent port on pump (if applicable)	Air trapped in pump	Open vent port and/or vent valve and bleed air
Noisy system	Pump	Bearings need lubrication (if applicable)	Oil per manufacturer's recommendation
		Air locked	Bleed air
	Piping	Entrapped air (direct systems only)	Purge system by running water up supply pipe and out drain on return line (isolation valves closed)
		Pipe vibration	Isolate piping from walls

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Controller does not turn on or off in the "automatic" mode but operates in the "manual" mode	Controller	Defective	Conduct function check and repair or replace
	Sensors	Defective sensors; resistance problem; sensors off scale	Check with multimeter (ohm). Correct or replace sensors.
		Improper contact or insulation	Ensure proper contact is made. Insulate sensors.
		Improper location	Relocate
	Wiring	Short or open	Replace or splice wire
System shuts off at wrong high limit or continues to Run	Controller	Defective	Repair or replace
	Sensors	Defective sensor	Check with multimeter (ohm) and replace
		Improper location	Relocate

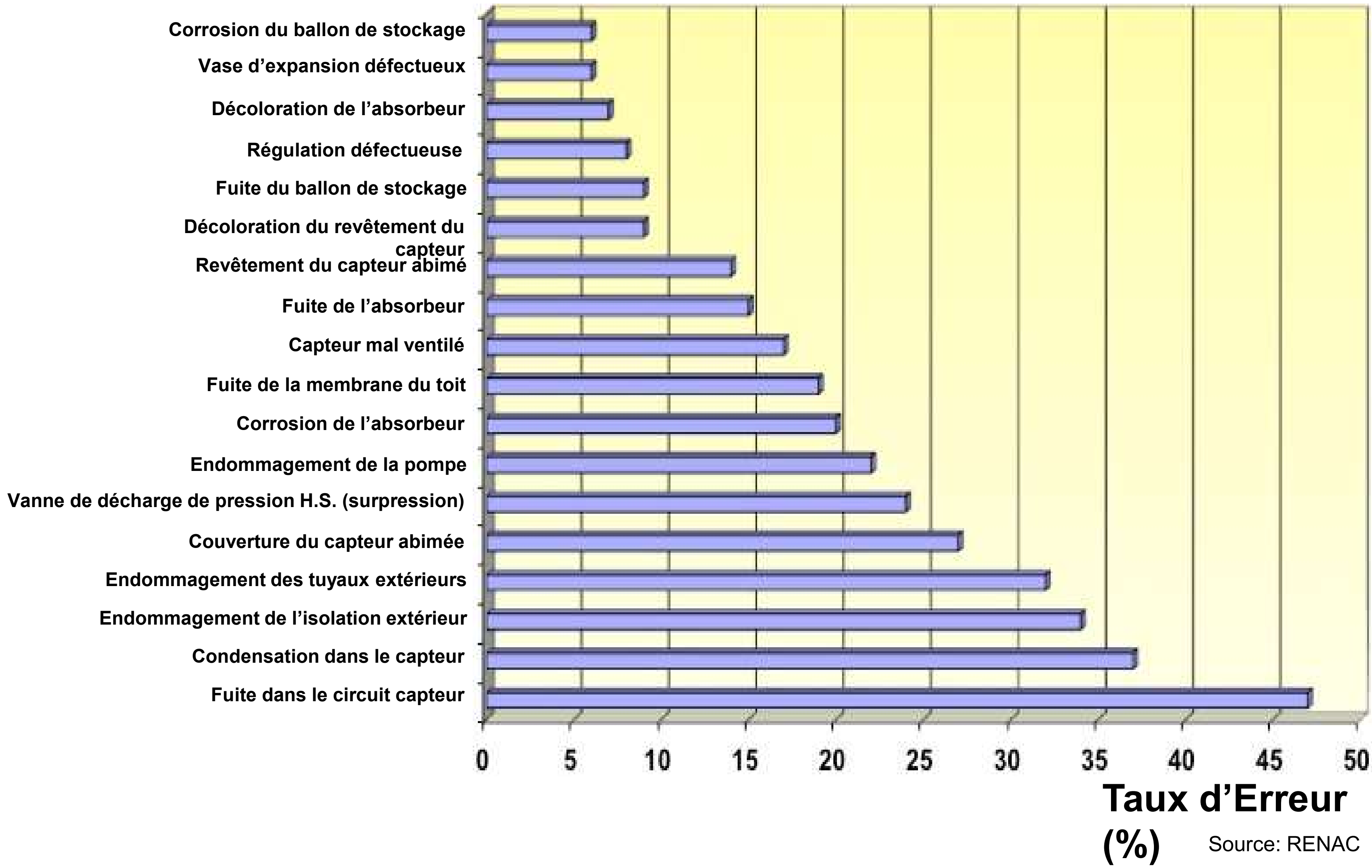
Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
System leaks	Collector(s)	Pipe burst due to freeze or defective joint	Repair or replace. Check freeze-protection mechanisms.
	Hose connection	Clamps not tightly secured	Tighten clamps. Replace clamp or hose.
	Pipe joints	Thermal expansion and contraction.	Replace and provide for flexibility
		Joint improperly made	Reassemble
		Improper seal in system using glycol solution	Make a good seal. Use recommended sealer. Note: glycol will leak through joints where water would not.
	Pressure relief valve	Did not reseal after opening	Replace
		Defective	Replace
		Improper pressure or temperature setting	Reset, if possible, or replace
	Valves	Valve gland nuts loose	Tighten nuts. Replace seal or packing if necessary.
		Seats deteriorating	Replace seat washers. Redress seat. Replace valve if necessary.

Maintenance & repair
Troubleshooting Checklist

PROBLEM	CHECK THIS	POSSIBLE CAUSE	CORRECTIVE ACTION
Water comes off the roof	Pressure relief valve	Defective seal	Replace
		Activates due to no circulation through collector(s)	Check flow in collector loop. (See “Pump does not start” and “Pump operational but no flow to collector.”)
	Collector piping	Defective piping	Repair or replace
	Low-pressure valve installed on collector supply line	Power loss. Pressure loss from well.	No action required.
System does not drain	Piping	Insufficient slope for drainage	Check and ensure piping slopes ¼" per foot of piping
	Event air	Does not open. Defective due to internal mechanism or corrosion.	Clean or replace

Maintenance & repair
Troubleshooting frequency



Source: RENAC

Maintenance & repair
Maintenance frequency

action	frequency	performed by:	remarks	precautions
collectors glass cleaning	After each 3 months for dirty environment	user/technician	with water and brush	collectors must be cool before cleaning/washing
Safety valve/group functionality	annually	technician	lift and release the lever on the temperature and safety valve to ensure valve operates freely	discharged water might be hot enough to present a scald hazard and should be directed to suitable drain using a proper hose.
electric element	annually	technician	testing with electrician's multimeter	shut off power before accessing and testing the element
electronic controller	annually	technician	Incoming and outgoing signals check. Connections and terminals	
hydraulic and piping leak check	annually	user/technician		caution for hot fluid or surfaces
electrical connections	annually	technician		shut off power

Maintenance & repair
Maintenance frequency

action	frequency	performed by:	remarks	precautions
piping insulation condition	annually	user/technician		
visual check for collector's glass condition	annually	user/technician		
stability of collectors support frames	annually	technician		
stability of water storage tank	annually	technician		
expansion tank	annually	technician	Leaks check. Pressure check at idle position. (2,5 bar solar , 1,5 bar water)	
thermal fluid level	annually	technician		
thermal fluid pump/s	annually	technician	Leaks check. Incoming and outgoing signals check. Connections and terminals	
magnesium anode rod	annually	technician	Magnesium anode rod is designed to prolong the life of the glass lined tank. It is slowly consumed thereby eliminating or minimizing corrosion of the tank	The tank should be drained to inspect and/or replace the magnesium anode rod.

SOLAR Heating
for Industrial Process
Together Toward Efficient Production

SWH: Procedural frame for Egyptian market

Training of SWH installer & maintainer

Ministry of Trade & Industry
وزارة التجارة والصناعة

UNIDO

ENCPC
Egypt National Cleaner Production Center

gef

DAY4 – PROCEDURAL FRAME
Egyptian market

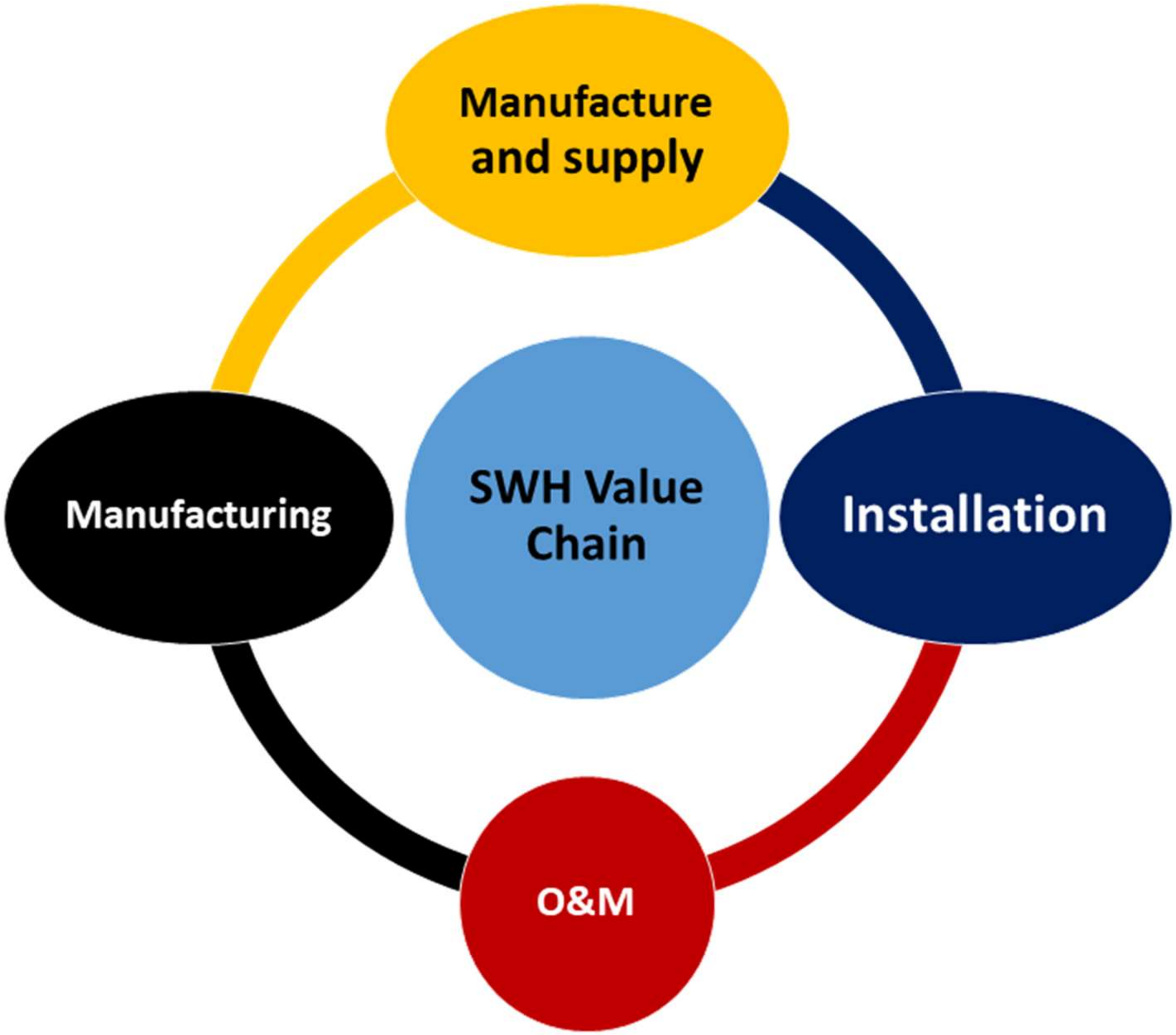
Objective:

- ✓ Be informed on the procedural frame
    - Organizational
    - Technical
- ✓ Have knowledge on the Egyptian market
- ✓ Have idea on the role of each involved stakeholder

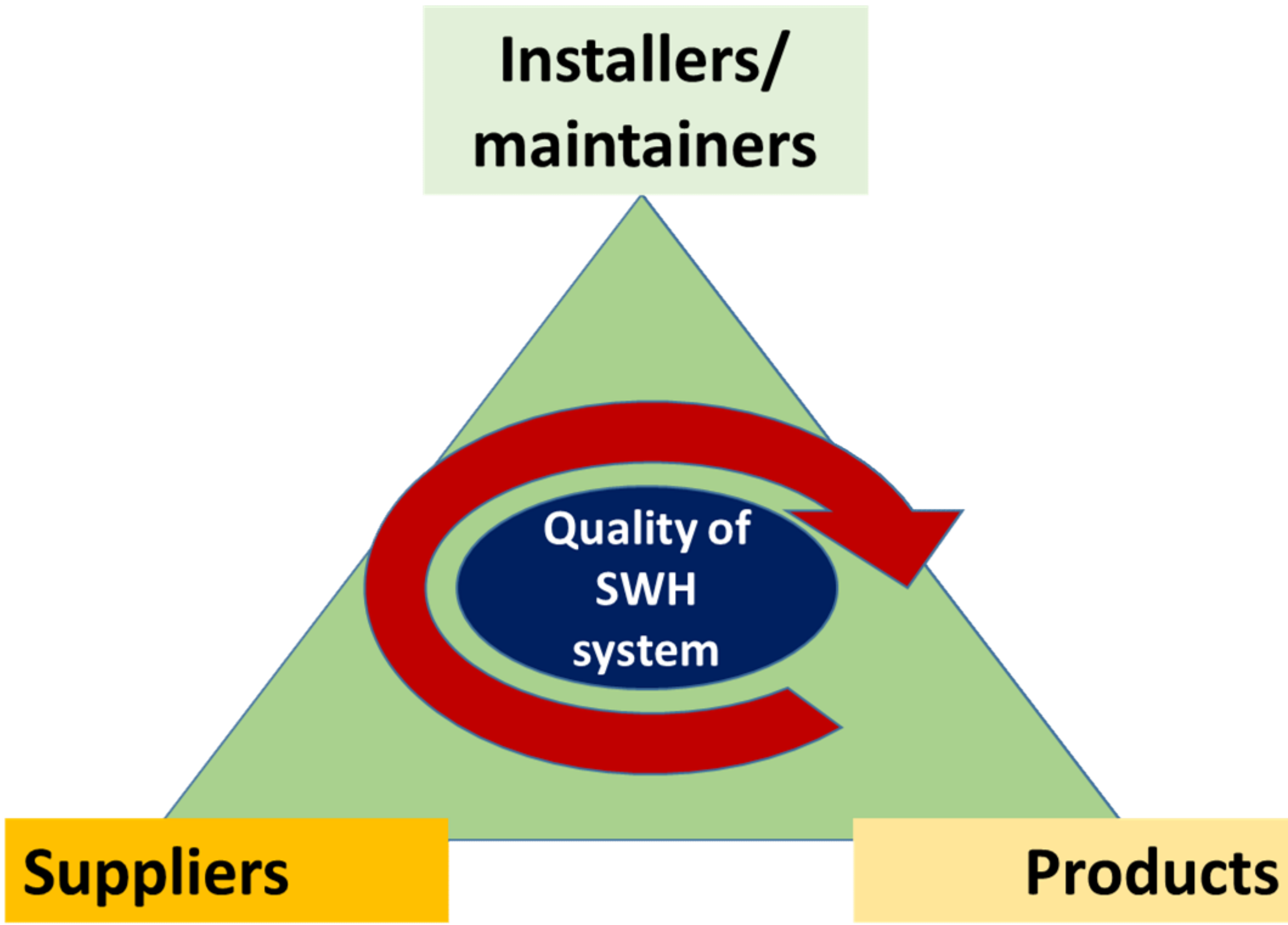
Duration

- ✓ 2:00 hours
- ✓ From 15:00 to 17:00
- ✓ Close phones
- ✓ Don’t speak to each other

DAY4 – PROCEDURAL FRAME
Egyptian market value chain



DAY4 – PROCEDURAL FRAME
Egyptian market quality



DAY4 – PROCEDURAL FRAME
Egyptian approach for SWHIM qualification

MCI/UNIDO

- Develop a short term competency based program for installers
- Validate the design and the program by the WG
- Write a 30 hours SWH curricula (5 days)
- Validate the program

Validation

EXAMINATION

- Elaborate the content of assessment (04 hours)
- Validate the assessment (04 hours)
- List of necessary equipment for exam
- Minimum score definition

Validation

Training Centres and ToT

- List of eligible training centres
- Infrastructure of Centres (list of equipment and HR)
- List of trainers to be trained
- Training of trainers (ToT)

Validation

IMPLEMENTATION

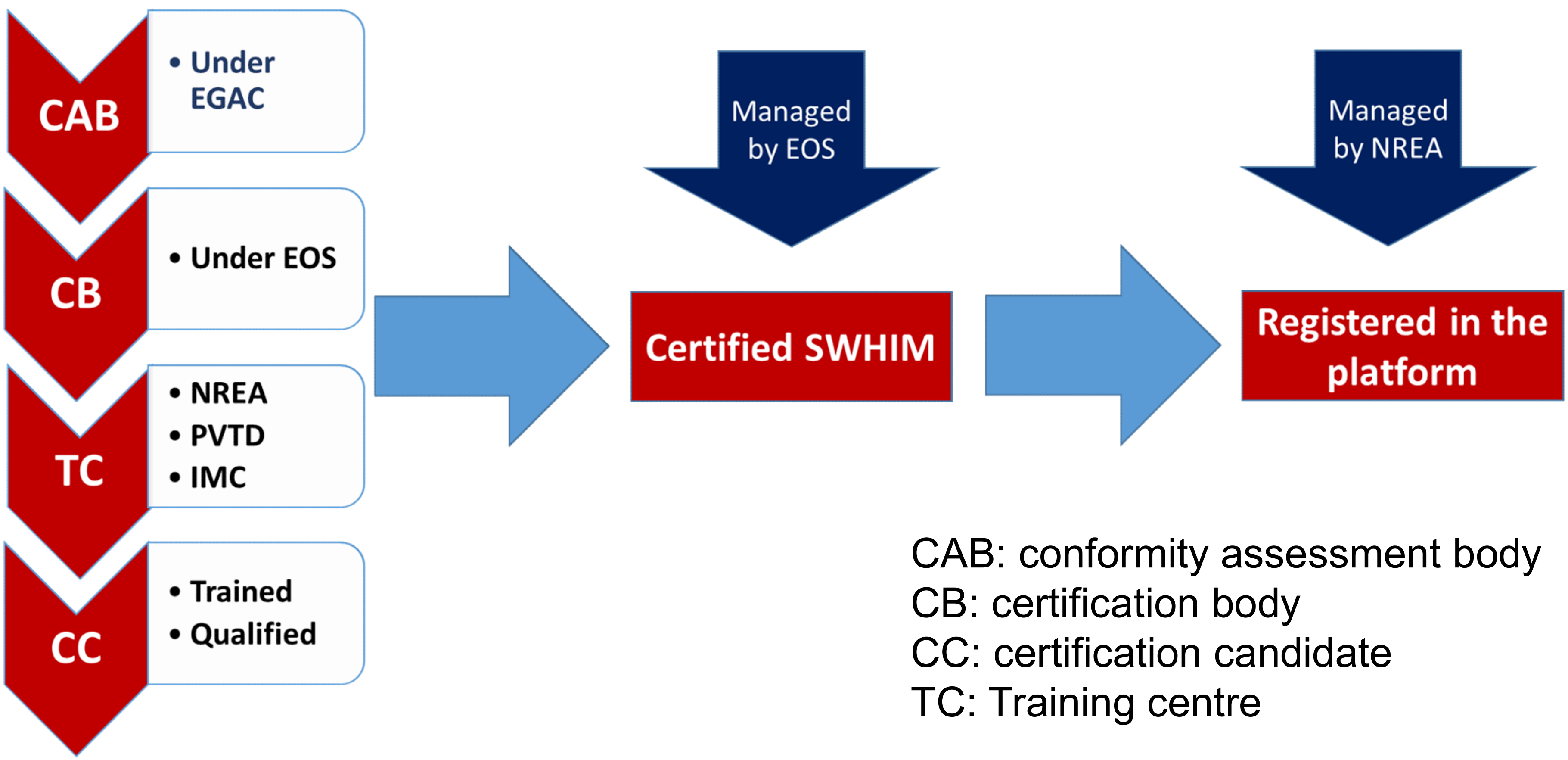
Eligible Centres for training

Training of candidates

Qualified installers to be certified for the market of SWH

Procedural frame
Organizational frame

Egyptian approach for SWHIM certification



CAB: conformity assessment body
CB: certification body
CC: certification candidate
TC: Training centre

Procedural frame
Organizational frame

Present the role of each stakeholder
Define the relation between installers and main stakeholders

- ❑ NREA: training centre of installers, manager of the SWH platform
- ❑ EOS: certification of installers according to ISO 17024
- ❑ EGAC: accreditation of the certification body
- ❑ MIT: policy for quality based market development
- ❑ PVTD: training centre of installers
- ❑ IMC: training centre of installers
- ❑ Personal : Installer-Maintainer
- ❑ Supplier: SWH provider and partner of installers
- ❑ Beneficiary: End user and installer client

Procedural frame
Organizational frame

MIT:
- Develop SWH value chain
- Monitoring of SWH market development
- Manage the SWH program.

EOS-EGAC:
- Define requirements of the SWH supply (minimum requirements to be respected by suppliers “Shamsi”)
- Define requirements for certification of SWH services providers (minimum requirements for installation and maintenance)
- Define qualification criteria of SWH installers and maintainers (training & examination)

SEDA-Cluster:
- Approve manual for installation, operation and maintenance of the SWH system
- Validate contract of services and “Q-Sol” label for installers
- Approve guarantee conditions of SWH
- Promotion of the SWH program and quality label for installation “Q-Sol”
- Awareness for quality improvement of SWH products and services
- Identify collaborative activities for SWH market development

Training provider (NREA, PVTD, IMC):
- Fulfil to requirements and specification of training centers (minimum requirement for training providers)
- Implement the training course developed and provide a certificate
- Contribute to improve the training courses through the monitoring

Procedural frame
Organizational frame

NREA:

- Monitoring of SWH platform
- Manage an update the SWH platform.

Supplier:

- Respect quality of the products (minimum requirements for SWH)
- Provide testing reports justifying the requested requirements
- Select and train installers on own SWH
- Contract with installers
- Provide guarantee of products for the installers
- Provide manual for installation, operation and maintenance of the SWH system

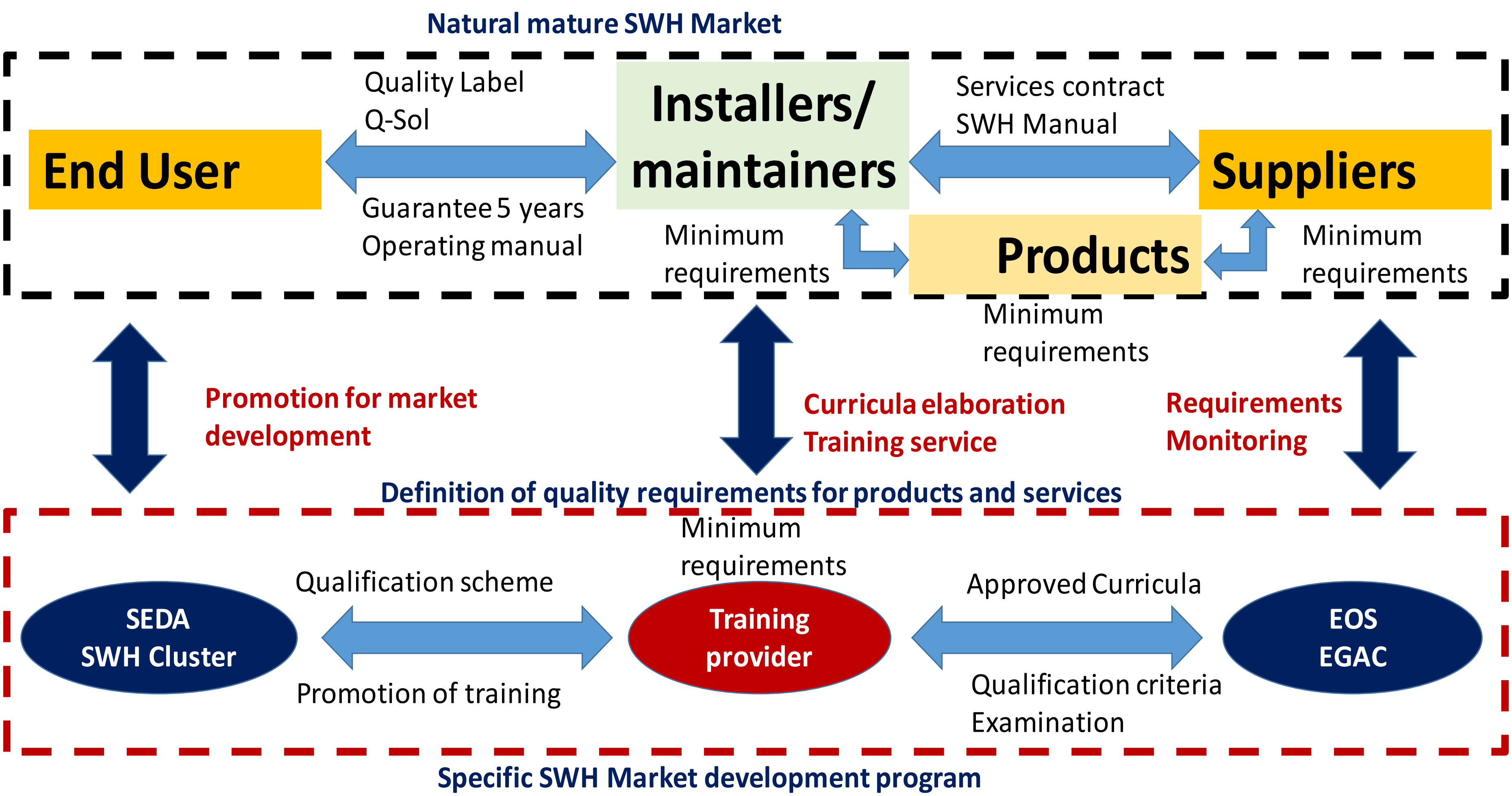
Installer:

- Provide advice to end user concerning SWH system type
- Respect quality requirements of SWH services
- Install SWH according to contract, quality requirements and "Q-Sol " label
- Provide guarantee and system O&M manual to end user
- Provide continued after sale services "ASS"

End User:

- Operation of SWH according to recommendations
- Preventive maintenance of the SWH system
- Monitoring of SWH system

Procedural frame
Organizational frame



Procedural frame
The scheme

- Technical specification relating to the SWH components eligibility (CHEMONICS)
- Guideline of best practices SWH installation and maintenance (SWH Manual for installation and maintenance)
- SWH Q-Sol charter
- Supplier/installer (contract)
- Minimum requirements for SWH training centre
- Minimum requirements for SWH installer/maintainer

YE3

The min. requiremenrt and the technical sep. must be illustrated with charts and descrption YE3

Yahia El-Masry, 04-Aug-20

Procedural Frame
Technical frame

SWH manual
•Objective
•Content
•How to use

Qualification & Certification
•Objective
•Procedures
•Obligations

Quality Charter
•Objective
•Presentation
•Discussion

Contract supplier/installers
•Objective
•Content
•Obligations

Other Specifications
Minimum requirements for installer/maintainer eligibility
Technical specifications related to supplier eligibility
Technical specifications relating to the SWH components eligibility

Data base (SWH platform)
Objective
Procedures
Obligations

SWH manual for installation and maintenance
Content

PART I: DEFINITIONS & PRELIMINARY CONCEPTS

This first part presents basic concepts on Solar Water Heater (SWH) system in the international technical and commercial market contexts. It covers the following topics:

- General definitions
- Comparative analysis of SWH types
- Role of components and accessories of a SWH
- Classification of solar systems
- Sizing elements of solar water heating installations

SWH manual for installation and maintenance
Content

PART II: SUPPLY & INSTALLATION OF AN INDIVIDUAL SWH

This second part of this manual describes all the steps that an installer needs to follow in order to carry out the installation of an individual SWH. It covers the following steps:

- Customer contact (preliminary visit and installation appointment)
- SWH delivery
- Prepare for installation
- SWH installation
- Commissioning
- Customer acceptance of the installation

This part allows installers to control the technical offer for SWH installation in order to get the compatible choices with the constraints of each installation and users' expectations.

SWH manual for installation and maintenance
Content

PART III: BEST PRACTICES AND RECOMMNDATIONS FOR PROPER AND CORRECT INSTALLATION

This third part includes 13 practices presented in the form of:

- Proscribed practices : describes the errors that the installer could make during the installation, these practices have to be avoided to guarantee an installation in accordance with the standards and the rules of the art
- Good practices: constitute the solutions to follow to avoid errors and installation anomalies

In addition to the prohibited practices, good installation practices are presented, with a view to optimum commissioning and operation. The operations mentioned constitute an essential complement to the technical specifications to disseminate good practices, ensure user satisfaction and reduce breakdowns and anomalies

SWH manual for installation and maintenance
Content

PART IV: SOLAR WATER HEATER MAINTENANCE AND REPAIR

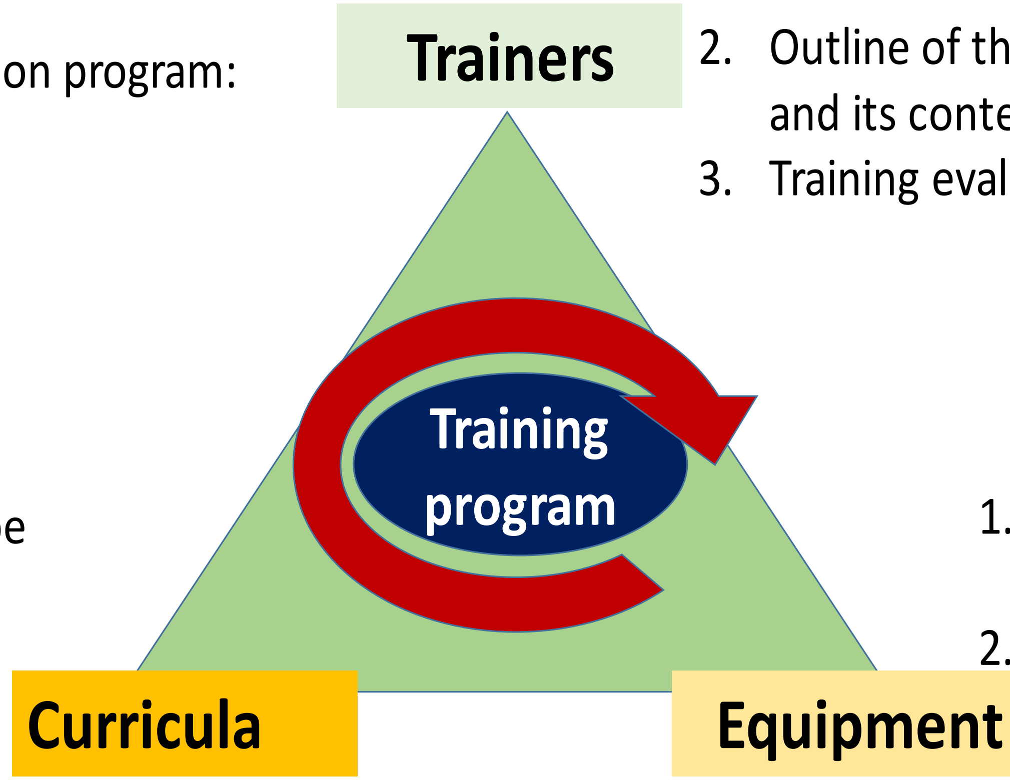
This part concerns the maintenance instructions to be followed by the installer and the customer to ensure a better use of the SWH, these maintenances are of three types:

- Systematic maintenance provided by the customer
- Preventive maintenance provided by the installer; during periodic visits carried under the guarantee period
- Corrective maintenance, provided by the installer in the event of a breakdown.

This manual should be followed and respected by the SWH installers and maintainers during the installation and maintenance activities.

SWH qualification approach
Content of the process

Needs for qualification program:



Trainers

1. ToT
2. Outline of the training and its content
3. Training evaluation

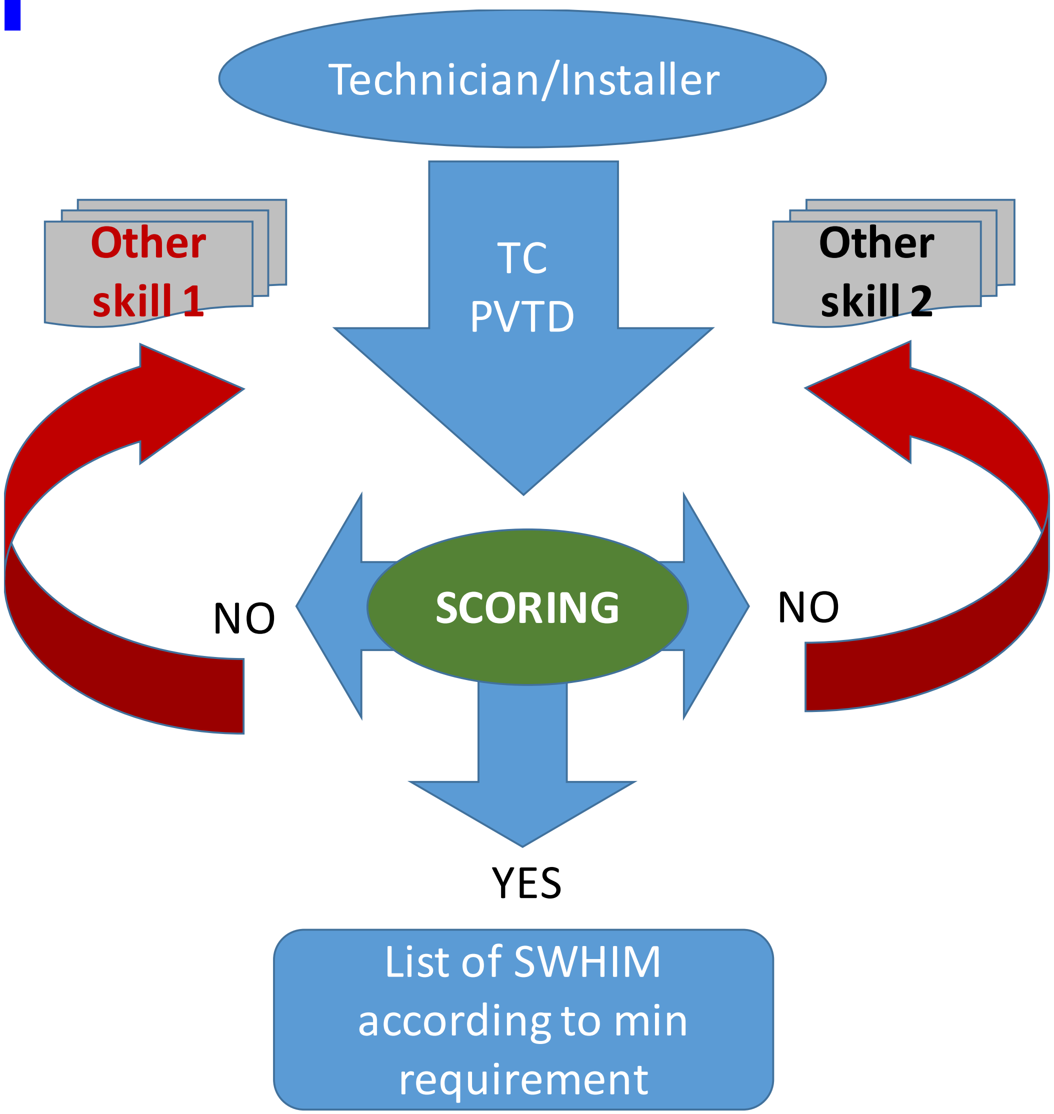
Curricula

1. Develop a unit to be inserted in the existing course/ program plumbers
2. Develop a short time curriculum for existing installers

Equipment

1. Identify centers to provide training
2. Implement the required infrastructure
3. Identify trainers

SWH qualification approach
Content of the process



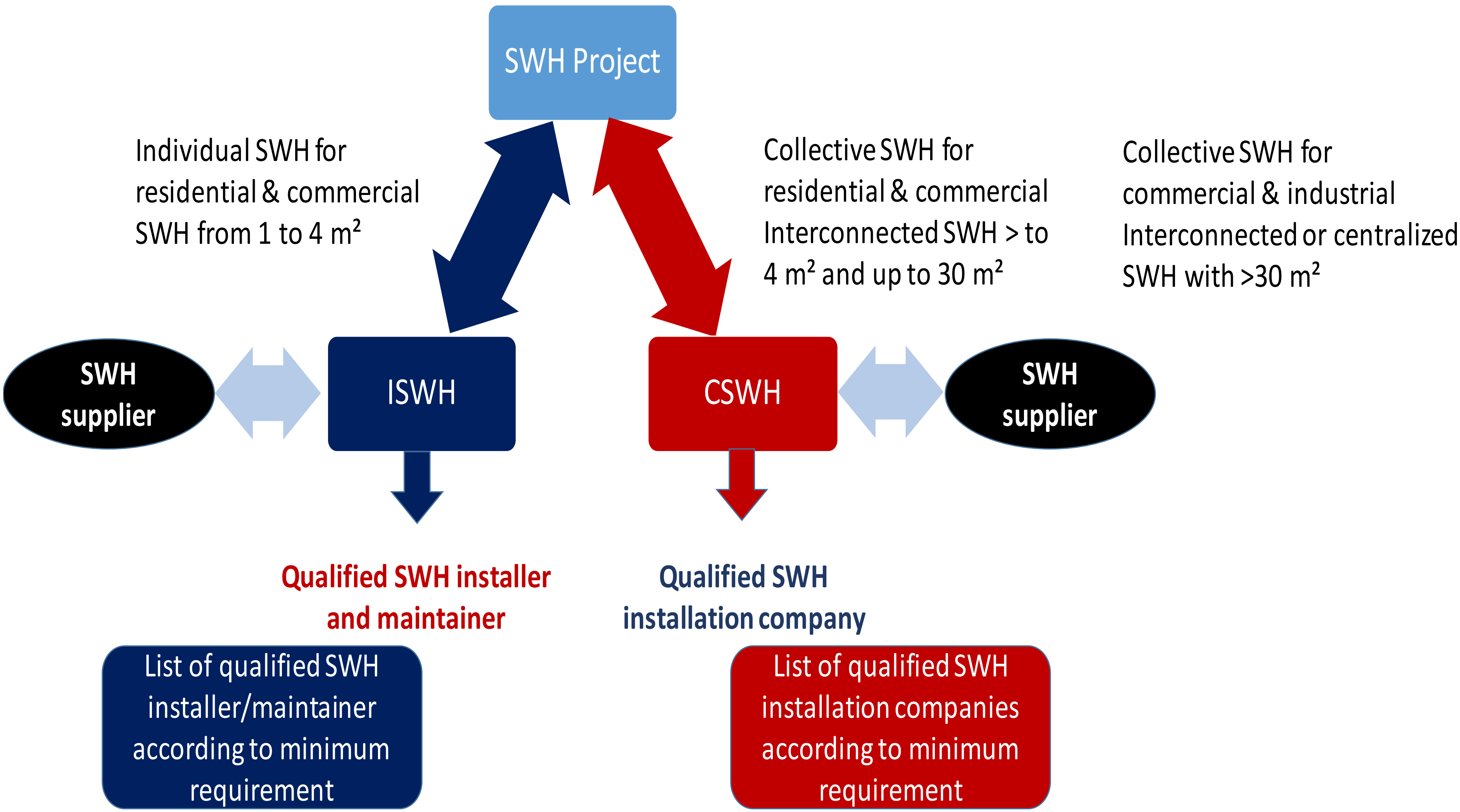
Competency based program for existing installers (5 days)
ToT
Minimum requirements for training Centres

Introduce SWH assessment

- Theory
- Practice
- interview

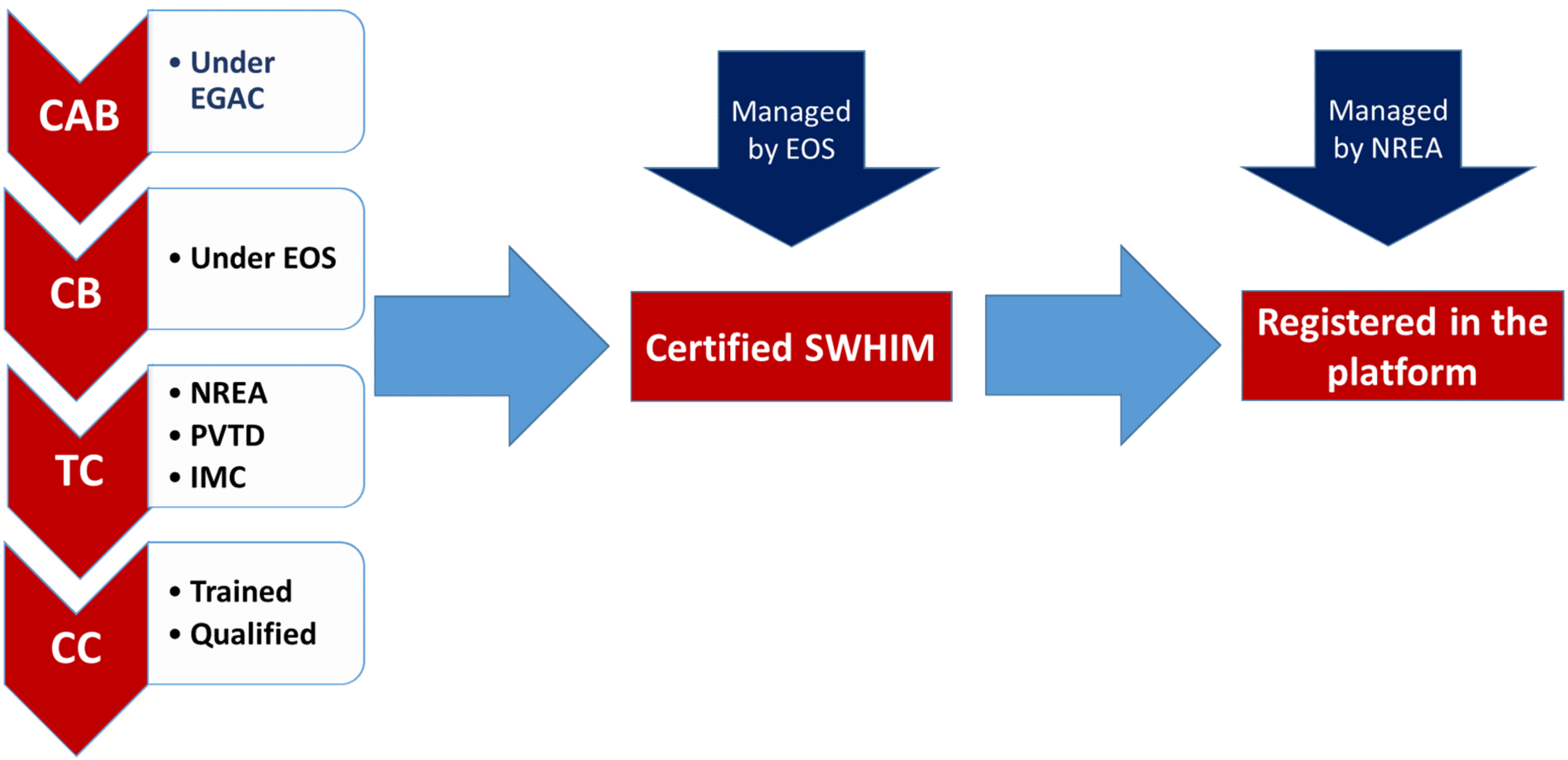
Qualified SWH installer and maintainer

SWH certification approach
Content of the process



SWH certification approach
Content of the process

Egyptian approach for SWHIM certification



SWH quality label
Content of the process

As an installer and maintainer of SWH, I hereby undertake to respect the following ten (10) points of the quality charter that lies to:

1. *Have the required professional skills within his own self or his company, attained through a long or a short term training as well as a confirmed practice, and be up to date within the applicable technical requirements*,
2. *Recommend and commercialize only solar systems that meet current standards and specifications and that are eligible for the Egyptian program by EOS, (Solar Key Mark or SHAMCI)*
3. *Provide the client with an advisory role, and assist him in the selection of the best available solutions suited to his needs and considering the local "solar potential", the constraints of the site, the size of the household and the available backup energies*,
4. *After the site visit, a written detailed and complete description of the proposed solar installation must be submitted to the client, setting a deadline for installation, payment conditions and legal guarantee terms, and then propose, for the client, a contract of maintenance for a minimum of 5 years*,
5. *Update the client on any changes and conditions or modalities related to the realization of the SWH installation (type, price, timeline, payment conditions, technical specifications …),*

SWH quality label
Content of the process

6. *Once the client's agreement is obtained (technical and financial proposal co-signed), insure to constitute the complete file in conformity with the requirements and carry out the ordered installation in accordance with applicable professional rules, standards and regulations as required*
7. *Set and commission the installation, then proceed to work receipt in the presence of the customer. Give him the instructions and all documents related to the guarantee and maintenance conditions; inform him about the operation of the SWH and its preventive maintenance needs*
8. *Provide the customer, as his counterpart, with a complete detailed and descriptive invoice of the service (that makes out at least the "equipment supply" and the "service fee", in accordance with the initial technical and financial description (with precise designation of installed solar equipment and references certification)),*
9. *In case of customer-reported malfunction or operational incidents on the SWH, commit to responding and to intervene in the site in a short time, and carry out necessary checks and intervention as part of the response obligations attached to the guarantee and maintenance contract*
10. *Following to any notification of the authority, any control operation that the institution would like to carry out on selected installations should be prioritized, in order to examine the SWH and check the conditions of service's implementation.*

SWH contract (Supplier/Installers)
Content of the process

The template of contract between supplier and installer for SWH installation and maintenance is aiming to define the roles, the tasks and the responsibilities for SWH installation and maintenance according to SWH value chain.

It aims also to organize the market, to separate between supply and services and to protect each other from any disagreement that could damage the SWH market

Suppliers of SWH and installer/maintainer must establish such contract in order to be eligible and to benefit from the existing incentive mechanism.

SWH training: Final exam

Training of SWH installer & maintainer

Ministry of Trade & Industry
وزارة التجارة والصناعة

Egypt National Cleaner Production Center

DAY 5 – Final Exam
Theory and practice

Objective:

- ✓ Assess the knowledge of the four days training
- ✓ Evaluate skills of installers
- ✓ Scoring the candidates for the certification

Duration

- ✓ 4 hours with one coffee break
- ✓ Theory: From 9:00 to 11:00
- ✓ Practice: From 11:30 to 13:30
- ✓ Close phones
- ✓ Don't speak to each other

Final exam
Part 1

- **Theory Post evaluation**
  - ✓ **40 QCM**
  - ✓ **2:00 hours**

Organization:

- ✓ Individual working
- ✓ Read the entire exam
- ✓ Give one or more responses for each question
- ✓ Follow the trainer instructions
- ✓ Use the manual of installation
- ✓ Remember to write you name

Final exam
Part 2

- **Practical Post evaluation**
  - ✓ **Real installation and maintenance**
  - ✓ **(2:00 hours)**

Organization:

- ✓ Work in small groups
- ✓ Identify SWH components
- ✓ Identify tools
- ✓ Follow the examiner instructions
- ✓ Follow the manual of installation
- ✓ Respect safety requirements
- ✓ Have the individual safety equipment's